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A STRUCTURAL WEIGHT ESTIMATION PROGRAM (SWEEP) FOR AIRCRAFT. VOLUME III - AIR-LOADS ESTIMATION MODULE

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Rockwell International Corporation

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Three computer programs were written with the objective of predicting the structural weight of aircraft through analytical methods. The first program, the structural weight estimation program (SWEEP), is a completely integrated program including routines for airloads, loads spectra, skin temperatures, material properties, flutter stiffness requirements, fatigue life, structural sizing, and for weight estimation of each of the major aircraft structural components. The program produces first-order weight estimates

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered) and indicates trends when parameters are varied. Fighters, bombers, and cargo aircraft can be analyzed by the program. The program operates within 100,000 octal units on the Control Data Corporation 6600 computer. Two stand-alone programs operating within 100,000 octal units were also developed to provide optional data sources for SWEEP. These include (1) the flexible airloads program to assess the effects of flexibility on lifting surface airloads, and (2) the flutter optimization program to optimize the stiffness distribution required for lifting surface flutter prevention.

The final report is composed of 11 volumes. This volume (Volume III) contains the methodology, program description, and user's information for the airload module of SWEEP.

PREFACE

This report was prepared by Rockwell International Corporation, Los Angeles Aircraft Division, Los Angeles, California, under Contract F33615-71-C-1922, No. FX2826-71-01876/C093. The work was performed for the Deputy for Development Planning, Air Force System Command, Wright-Patterson Air Force Base, Ohio, and extended from September 1971 to June 1974.

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D. Konishi - Advanced Composites
C. Hodson - Structural Dynamics

The final report was published in 11 volumes; the complete list is as follows:

Volume	
I	"Executive Summary"
II	"Program Integration and Data Management Module"
III	"Airloads Estimation Module"
IV	"Material Properties, Structure Temperature, Flutter, and Fatigue"
V	"Air Induction System and Landing Gear Modules"
VI	"Wing and Empennage Module"
VII	"Fuselage Module"
VIII	"Programmer's Manual"
IX	"User's Manual"
X	"Flutter Optimization Stand-Alone Program"
XI	"Flexible Airloads Stand-Alone Program"

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Section I

INTRODUCTION AND SUMMARY

SUMMARY OF CAPABILITIES

Two main functions of the loads module are the development of design airloads and wing fatigue spectrum data for fixed or variable sweep-wing fighter, attack, bomber, and transport vehicle categories. Different general arrangements that can be evaluated are:

1. Conventional aft horizontal tail

2. Forward fuselage-mounted horizontal tail (canard)

3. Single or twin vertical tails

4. T-type vertical tail

Component airloads and centers of pressure are calculated for a number of flight conditions to provide reasonable expectation that the maximum airloads are encompassed. These conditions include both flaps-up and flaps-down cases as well as critical maneuver and gust conditions along the vehicle speed-altitude profile. Limit airload shear, bending moment, and torsion are calculated at stations along the load reference line for each of the lifting surfaces. Airload shear, bending moment, and torque are combined with the surface inertia loads to determine a critical design load envelope for the wing, horizontal tail, and vertical tail. Material properties at the structure temperature, load factor, and weight of contents at the specific condition enter into the derivation of critical design loads at each weight analysis station. Net fuselage loads are calculated within the fuselage weight estimating module which uses the matrix of airload data generated within this module.

Wing bending moment spectra are calculated at two wing stations for a specified service life and number of landings. Flight spectra are calculated from specified blocked mission usage segments and load factor exceedence tables for the different vehicle categories. Spectra data is transmitted to the fatigue module which calculates the wing allowable operating tensile stresses.

MODULE STRUCTURE AND OPERATION

This program is written in FORTRAN IV extended programming language for operation on the CDC 6600 computer and is structured in a single overlay within 50,000 octal core locations. Execution of this module is dependent on data calculated in the data management module and the flutter and temperature module.

Program calculation options and output are controlled by user specifications. Output consists of all load calculations as well as temperature data generated in the flutter and temperature module.

Section II

METHODS AND FORMULATIONS

AIRLOAD COMPUTING MODULE FUNCTIONS

The objective of the loads module is to determine the design airloads on the structural components for use in the structural weight estimation process. A second function of this module is the development of wing bending moment spectra for fatigue evaluation.

The methods used to determine loads on the air vehicle structural components are sensitive to vehicle weight, center-of-gravity position, design speeds, design limit maneuver load factors, and the configuration geometry. The geometry of the lifting surfaces are described in terms of area, aspect ratio, taper ratio, sweep angle, and fuselage stations of the leading edges of the theoretical root chords (Figures 1 and 2). Body geometry is described in terms of body nose length, nose volume, maximum equivalent radius, and the fuselage station of the nose leading edge.

Specific load calculating functions are divided into separate routines which are called by the load control program BLCNTL. Methods employed are described herein and are presented in the order that subroutines USPAN, BNLDS, SPABM, MAXLDS, WHVNET, and FATMG are used.

Subroutine USPAN calculates the following data for the airplane lifting surfaces for specific mach numbers:

1. Unit airload shear, bending moment, and torsional moment distributions

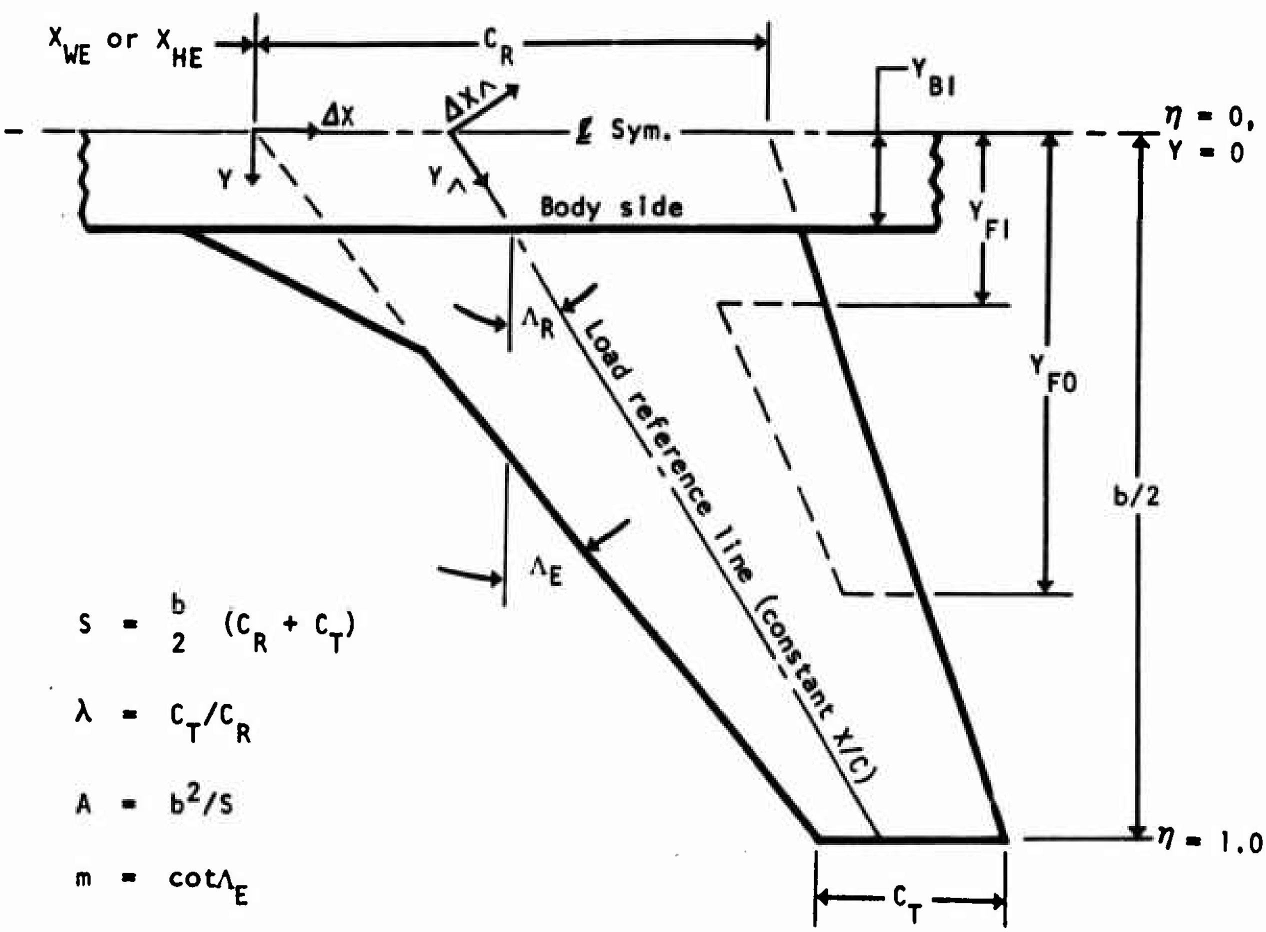
2. Centers-of-pressure locations for each of the surface airloads

3. Lift-curve slopes for each of the surfaces

Subroutine BNLDS calculates the airplane component gross limit airloads and their centers of pressure for specific flight conditions.

Subroutine SPABM calculates the limit airload shear, bending moment, and torsion at stations along the load reference line on each of the lifting surfaces for each of the specific flight conditions.

Subroutine FUSNET organizes the calculated loads data and stores it for use by the fuselage weight estimating module.



$$S = \frac{b}{2}(C_R + C_T)$$

$$\lambda = C_T/C_R$$

$$A = b^2/S$$

$$m = \cot\Lambda_E$$

$$\eta = \frac{Y}{b/2} = \frac{Y}{b_\Lambda/2}$$

Figure 1. Wing or horizontal tail lifting surface geometry.

$$S_v = (C_R + C_T)(b_v/2)$$

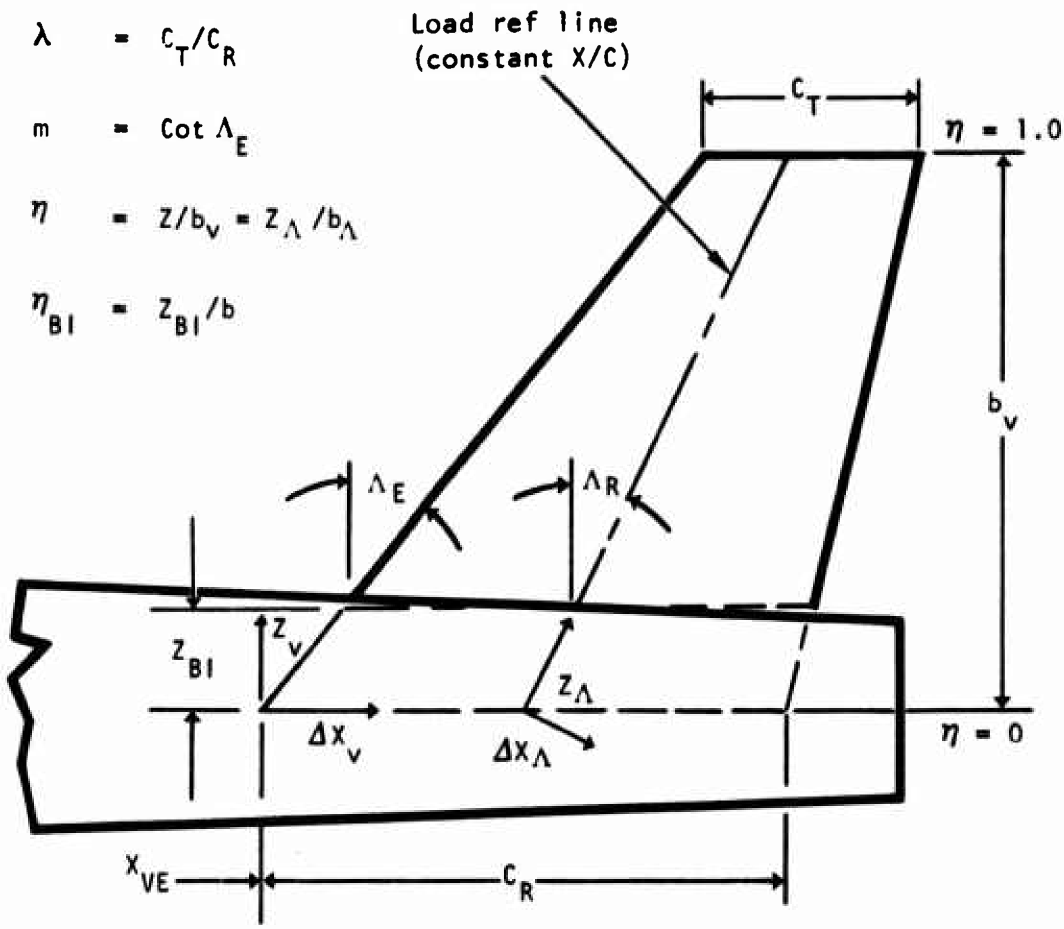
$$A_v = b_v^2/S_v$$

$$\lambda = C_T/C_R$$

$$m = \operatorname{Cot} \Lambda_E$$

$$\eta = Z/b_v = Z_\Lambda/b_\Lambda$$

$$\eta_{BI} = Z_{BI}/b$$



X_{VE} = Fuselage station of the theoretical surface apex

Figure 2. Vertical tail lifting surface geometry.

Subroutine MAXLDS determines the net design loads envelope for each of the lifting surfaces.

Subroutine WHVNET organizes the design loads envelope data, calculates normalizing factors, and stores the data for use by the wing and empennage weight estimating module.

Subroutine FATMG calculates the wing bending moment spectra at two wing stations for a specified service life and number of landings, using specified blocked usage segments and the specified airplane class.

BASIC FLIGHT CONDITIONS

The airloads on the structural components are determined for a number of selected flight conditions to provide a reasonable expectation that the maximum component airloads are encompassed. The speed-altitude points and types of conditions selected at each point are shown in Figure 3. The types of conditions which may produce maximum airloads on each component are as follows:

1. For the wing:

   a. Balanced maneuvers at the specified design limit positive maneuver load factor at the specified basic flight design weight at speed-altitude points 1, 2, 3, 7, and 10 (Figure 3).

   b. Balanced maneuvers at the specified design limit flaps-down maneuver load factor at the specified maximum design weight at speed-altitude point 8

   c. Balanced maneuvers at the specified design limit negative maneuver load factor at the specified basic flight design weight at speed-altitude points 4 and 10

   d. The positive and negative vertical gust conditions at the specified basic flight design weight at the speed-altitude points 4, 5, 10, and 11

2. For the horizontal tail:

   a. The balanced maneuvers of the foregoing items 1a, 1b, and 1c

   b. The vertical gust conditions of item 1d

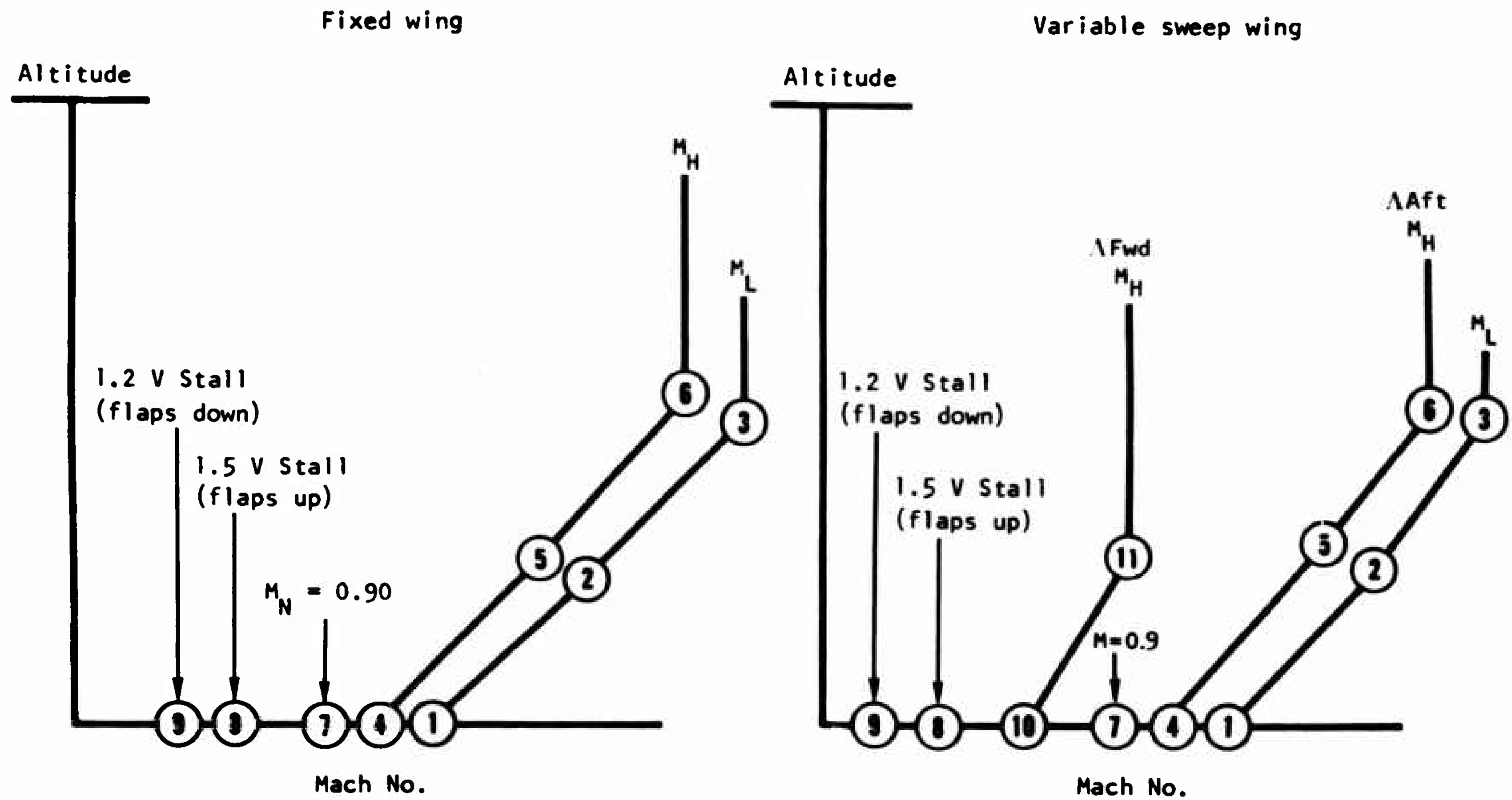


Figure 3. Speed altitude points and flight conditions.

c. The pitch acceleration conditions at one-half the specified design limit positive maneuver load factor at the specified pitching acceleration at the basic flight design weight at speed-altitude points 1 and 3

3. For the vertical tail:

   a. The lateral gust conditions at the specified basic flight design weight at speed-altitude points 4, 5, 10, and 11

   b. The yaw acceleration conditions at the specified yaw acceleration at the specified basic flight design weight at the speed-altitude points 1 and 3

4. For the fuselage:

   a. The balance maneuver conditions of the foregoing items 1a, 1b, and 1c

   b. The vertical gust conditions of item 1d

   c. The pitch acceleration conditions of item 2c

DETERMINATION OF LIFTING SURFACE UNIT AIRLOADS

The methods of analysis used to develop the lifting surface unit airload distributions, the surface lift curve slopes, and the surface airload centers of pressure are presented in the following paragraphs. The unit airloads are defined, and the basic data used for the determination of the surface unit airloads are also presented.

The unit airload shears and moments are determined at 13 selected spanwise η stations along the selected load reference line including the root and tip stations. The unit airload shear and moments at the surface-body interface station are determined in the unswept (body axes) system. The overall centers-of-pressure locations of the exposed panel and body carryover loads are determined with respect to the theoretical surface apex.

UNIT AIRLOAD SHEAR

The unit airload shear, USZ or USY, on the surface at any spanwise station, η, is defined as the integral from η to 1.0 of the normalized spanwise loading parameter, $(C_{\ell}'C/C_L C_{AV})$, where total load on the surface is 1.0, i.e.,

$$USZ_\eta \text{ or } USY_\eta = \int_\eta^{1.0} \left(\frac{C_\ell' C}{C_L C_{AV}}\right) d\eta \qquad (1)$$

and equals 1.0 at station $\eta = 0$

UNIT AIRLOAD BENDING MOMENT

The unit airload bending moment, UMX, at any spanwise station, η, is defined as the integral of the unit shear, USZ or USY, along the load reference axis, i.e.:

$$UMX_\eta = \frac{b}{2 \cos \Lambda_R} \int_\eta^1 USZ \, d\eta \qquad (2)$$

and

$$UMX_\eta = \frac{b_V}{\cos \Lambda_R} \int_\eta^1 USY \, d\eta \qquad (2a)$$

where Λ_R is the sweep angle of the load reference line.

UNIT AIRLOAD TORSIONAL MOMENT

The unit airload torsional moment, UMY or UMZ, about the surface load reference line and at any station, η, is defined as the integral of the product of the normalized spanwise loading parameter times the normal distance from the load reference line to the local center of pressure, ΔX_Λ, i.e.:

$$UMY_\eta \text{ or } UMZ_\eta = -\int_\eta^1 \left[\left(\frac{C_\ell C}{C_L C_{AV}}\right) \Delta X_\Lambda\right] d\eta \qquad (3)$$

CONVERSION TO DIMENSIONAL VALUES

The unit airload shears and moments are determined for a 1.0-pound gross surface load at selected η spanwise stations. When the gross surface limit airload is known, the conversion to limit shears and moments are determined as follows: The η stations are percent of semispan stations and are converted to span stations in inches along the load reference line. Then, the dimensional span stations for the wing or horizontal tail is

$$Y_\Lambda = \eta\,(b/2)/\cos\Lambda_R \tag{4}$$

and for the vertical tail is

$$Z_\Lambda = \eta\,(b)/\cos\Lambda_R \tag{5}$$

The wing and horizontal tail limit airload shear, S_Z, the bending moment, $M_{X\Lambda}$, and the torsional moment, $M_{Y\Lambda}$, at any span station Y_Λ are determined as follows where P_{ZS} is the wing or horizontal tail panel limit airload:

$$S_Z = P_{ZS}\,USZ \tag{6}$$

$$M_{X\Lambda} = P_{ZS}\,UMX \tag{7}$$

$$M_{Y\Lambda} = P_{ZS}\,UMY \tag{8}$$

Similarly for the vertical tail, the limit shear, S_Y, bending moment, $M_{X\Lambda}$, and torsional moment, $M_{Z\Lambda}$, at any station, Z_Λ, are determined as follows where P_{YS} is the vertical tail panel limit airload:

$$S_Y = P_{YS}\,USY \tag{9}$$

$$M_{X\Lambda} = P_{YS}\,UMX \tag{10}$$

$$M_{Z\Lambda} = P_{YS}\,UMZ \tag{11}$$

The limit airload moments, M_X, M_Y, and M_Z, in the unswept (body axes) system at the surface-body interface station Y_{BI} (Figure 1) or Z_{BI} (Figure 2) are as follows:

For the wing or horizontal tail

$$M_X = M_{X\Lambda} \cos \Lambda_R + M_{Y\Lambda} \sin \Lambda_R \tag{12}$$

$$M_Y = M_{Y\Lambda} \cos \Lambda_R - M_{X\Lambda} \sin \Lambda_R \tag{13}$$

and for the vertical tail

$$M_X = M_{X\Lambda} \cos \Lambda_R + M_{Z\Lambda} \sin \Lambda_R \tag{12a}$$

$$M_Z = M_{Z\Lambda} \cos \Lambda_R - M_{X\Lambda} \sin \Lambda_R \tag{13a}$$

where the moment $M_{X\Lambda}$, $M_{Y\Lambda}$, and $M_{Z\Lambda}$ are the limit airload moments along the load reference line at station $Y_\Lambda = Y_{BI}/\cos \Lambda_R$ or $Z_\Lambda = Z_{BI}/\cos \Lambda_R$.

BASIC DATA FOR UNIT AIRLOAD DETERMINATION

LIFTING SURFACE AERODYNAMIC DATA

The unit airloads for the lifting surface is defined as the shear, bending moment, and torsion versus span for a total surface panel airload of 1 pound. The total surface panel load includes the carryover load on the body. The exposed surface load is the load outboard of the body-surface interface station.

The unit airload distributions are developed using precalculated spanwise lift distributions from references 1 through 4. These data are tabulated and stored in the SWEEP program data bank.

For subsonic speeds, these data are obtained from Figures 3 and 4 of reference 1 and consist of the variation of the spanwise loading parameter, $(C_\ell C/C_L C_{AV})$, due to angle of attack and the lift-curve slope parameter, $(BC_{L\alpha}/K)$, with the compressible sweep parameter, Λ_B, for various values of the aspect-ratio parameter, (BA/K), and taper ratio, λ. The lift distribution due to wing flap deflection is obtained from Figure 32(c) of reference 2 where the spanwise loading parameter, $(C_\ell C/C_{AV} C_L)$, is presented for various percent of span flaps. These subsonic data are presented in Tables 1, 2, and 3.

TABLE 1. SUBSONIC SPAN LOADING PARAMETER, $C_\ell C/C_L C_{AV}$

η	λ	BA/K	$C_\ell C/C_L C_{AV}$					
			Λ_B=0°	Λ_B=15°	Λ_B=30°	Λ_B=45°	Λ_B=60°	Λ_B=75°
0.0	0.0	1.5	1.355	1.340	1.325	1.310	1.300	1.295
0.0	0.0	2.5	1.405	1.380	1.352	1.322	1.310	1.298
0.0	0.0	3.5	1.450	1.405	1.372	1.340	1.312	1.301
0.0	0.0	4.5	1.480	1.430	1.387	1.350	1.314	1.304
0.0	0.0	6.0	1.520	1.457	1.400	1.355	1.316	1.306
0.0	0.0	8.0	1.580	1.493	1.420	1.360	1.318	1.308
0.0	0.0	10.0	1.610	1.520	1.435	1.370	1.320	1.310
0.0	0.25	1.5	1.307	1.300	1.286	1.265	1.232	1.140
0.0	0.25	2.5	1.332	1.302	1.278	1.240	1.175	1.070
0.0	0.25	3.5	1.346	1.305	1.267	1.215	1.135	1.020
0.0	0.25	4.5	1.360	1.307	1.260	1.200	1.100	1.000
0.0	0.25	6.0	1.382	1.310	1.250	1.180	1.080	0.970
0.0	0.25	8.0	1.400	1.312	1.232	1.140	1.045	0.940
0.0	0.25	10.0	1.420	1.315	1.220	1.120	1.005	0.880
0.0	0.50	1.5	1.290	1.280	1.265	1.242	1.183	1.035
0.0	0.50	2.5	1.291	1.270	1.240	1.185	1.100	0.945
0.0	0.50	3.5	1.292	1.255	1.200	1.140	1.030	0.860
0.0	0.50	4.5	1.293	1.240	1.180	1.100	0.970	0.785
0.0	0.50	6.0	1.296	1.230	1.150	1.050	0.915	0.710
0.0	0.50	8.0	1.300	1.210	1.120	1.010	0.860	0.[illegible]
0.0	0.50	10.0	1.305	1.200	1.090	0.950	0.770	0.520
0.0	1.00	1.5	1.267	1.252	1.225	1.190	1.090	0.890
0.0	1.00	2.5	1.250	1.212	1.163	1.090	0.960	0.750
0.0	1.00	3.5	1.235	1.180	1.107	1.010	0.880	0.700
0.0	1.00	4.5	1.215	1.145	1.060	0.945	0.805	0.610
0.0	1.00	6.0	1.185	1.100	1.002	0.885	0.740	0.550
0.0	1.00	8.0	1.167	1.067	0.945	0.810	0.660	0.460
0.0	1.00	10.0	1.140	1.025	0.892	0.745	0.575	0.350

TABLE 1. SUBSONIC SPAN LOADING PARAMETER, $C_{\ell}C/C_{L}C_{AV}$ (CONT)

η	λ	BA/K	$C_{\ell}C/C_{L}C_{AV}$					
			$\Lambda_B=0°$	$\Lambda_B=15°$	$\Lambda_B=30°$	$\Lambda_B=45°$	$\Lambda_B=60°$	$\Lambda_B=75°$
0.383	0.0	1.5	1.220	1.207	1.200	1.200	1.201	1.210
0.383	0.0	2.5	1.235	1.220	1.212	1.212	1.215	1.230
0.383	0.0	3.5	1.240	1.227	1.221	1.225	1.230	1.245
0.383	0.0	4.5	1.250	1.240	1.232	1.230	1.245	1.260
0.383	0.0	6.0	1.260	1.257	1.250	1.245	1.250	1.270
0.383	0.0	8.0	1.270	1.270	1.273	1.275	1.290	1.300
0.383	0.0	10.0	1.265	1.265	1.265	1.270	1.280	1.295
0.383	0.25	1.5	1.185	1.180	1.180	1.180	1.175	1.150
0.383	0.25	2.5	1.185	1.180	1.180	1.180	1.175	1.150
0.383	0.25	3.5	1.184	1.180	1.180	1.170	1.166	1.135
0.383	0.25	4.5	1.183	1.180	1.180	1.170	1.166	1.135
0.383	0.25	6.0	1.182	1.180	1.180	1.165	1.155	1.120
0.383	0.25	8.0	1.181	1.180	1.180	1.165	1.155	1.120
0.383	0.25	10.0	1.177	1.176	1.175	1.160	1.150	1.100
0.383	0.50	1.5	1.180	1.180	1.180	1.175	1.165	1.140
0.383	0.50	2.5	1.180	1.180	1.175	1.162	1.150	1.112
0.383	0.50	3.5	1.180	1.170	1.165	1.150	1.140	1.090
0.383	0.50	4.5	1.170	1.165	1.160	1.145	1.120	1.080
0.383	0.50	6.0	1.160	1.160	1.155	1.132	1.110	1.055
0.383	0.50	8.0	1.155	1.155	1.150	1.120	1.090	1.035
0.383	0.50	10.0	1.145	1.140	1.130	1.105	1.070	1.005
0.383	1.00	1.5	1.175	1.170	1.170	1.680	1.160	1.135
0.383	1.00	2.5	1.170	1.165	1.162	1.155	1.135	1.070
0.383	1.00	3.5	1.165	1.160	1.155	1.142	1.110	1.020
0.383	1.00	4.5	1.152	1.150	1.145	1.122	1.080	0.970
0.383	1.00	6.0	1.140	1.140	1.130	1.105	1.045	0.920
0.383	1.00	8.0	1.120	1.120	1.117	1.080	1.010	0.890
0.383	1.00	10.0	1.112	1.112	1.098	1.060	0.980	0.845

TABLE 1. SUBSONIC SPAN LOADING PARAMETER, $C_{\ell}C/C_{L}C_{AV}$ (CONT)

η	λ	BA/K	$C_{\ell}C/C_{L}C_{AV}$					
			Λ_B=0°	Λ_B=15°	Λ_B=30°	Λ_B=45°	Λ_B=60°	Λ_B=75°
0.707	0.0	1.5	0.855	0.862	0.870	0.870	0.870	0.875
0.707	0.0	2.5	0.825	0.842	0.850	0.860	0.868	0.874
0.707	0.0	3.5	0.800	0.825	0.840	0.860	0.865	0.872
0.707	0.0	4.5	0.780	0.805	0.830	0.850	0.860	0.870
0.707	0.0	6.0	0.750	0.785	0.810	0.840	0.858	0.868
0.707	0.0	8.0	0.720	0.766	0.800	0.830	0.855	0.867
0.707	0.0	10.0	0.700	0.740	0.775	0.810	0.842	0.865
0.707	0.25	1.5	0.880	0.890	0.900	0.915	0.935	0.970
0.707	0.25	2.5	0.875	0.887	0.903	0.920	0.950	0.998
0.707	0.25	3.5	0.860	0.884	0.907	0.927	0.960	1.010
0.707	0.25	4.5	0.850	0.880	0.910	0.940	0.990	1.045
0.707	0.25	6.0	0.840	0.876	0.913	0.950	1.000	1.070
0.707	0.25	8.0	0.830	0.873	0.917	0.960	1.015	1.090
0.707	0.25	10.0	0.815	0.870	0.920	0.970	1.030	1.100
0.707	0.50	1.5	0.890	0.900	0.905	0.920	0.955	1.030
0.707	0.50	2.5	0.890	0.900	0.922	0.955	1.005	1.085
0.707	0.50	3.5	0.890	0.910	0.940	0.980	1.030	1.110
0.707	0.50	4.5	0.890	0.920	0.955	0.995	1.055	1.150
0.707	0.50	6.0	0.890	0.930	0.970	1.015	1.085	1.185
0.707	0.50	8.0	0.890	0.935	0.985	1.040	1.110	1.230
0.707	0.50	10.0	0.890	0.945	1.000	1.070	1.155	1.260
0.707	1.00	1.5	0.910	0.910	0.920	0.950	1.000	1.130
0.707	1.00	2.5	0.920	0.940	0.970	1.010	1.090	1.215
0.707	1.00	3.5	0.935	0.960	0.995	1.055	1.130	1.250
0.707	1.00	4.5	0.947	0.985	1.030	1.090	1.165	1.285
0.707	1.00	6.0	0.960	1.005	1.060	1.120	1.200	1.310
0.707	1.00	8.0	0.980	1.030	1.090	1.160	1.250	1.350
0.707	1.00	10.0	0.990	1.050	1.115	1.195	1.290	1.400

TABLE 1. SUBSONIC SPAN LOADING PARAMETER, $C_\ell C/C_L C_{AV}$ (CONCL)

η	λ	BA/K	$C_\ell C/C_L C_{AV}$					
			Λ_B=0°	Λ_B=15°	Λ_B=30°	Λ_B=45°	Λ_B=60°	Λ_B=75°
0.924	0.0	1.5	0.390	0.415	0.420	0.438	0.445	0.420
0.924	0.0	2.5	0.340	0.367	0.390	0.402	0.410	0.400
0.924	0.0	3.5	0.305	0.340	0.367	0.382	0.395	0.390
0.924	0.0	4.5	0.285	0.318	0.347	0.365	0.380	0.380
0.924	0.0	6.0	0.252	0.290	0.320	0.350	0.362	0.360
0.924	0.0	8.0	0.200	0.245	0.288	0.312	0.340	0.340
0.924	0.0	10.0	0.207	0.250	0.292	0.316	0.342	0.350
0.924	0.25	1.5	0.465	0.480	0.485	0.495	0.515	0.600
0.924	0.25	2.5	0.464	0.483	0.495	0.520	0.570	0.660
0.924	0.25	3.5	0.462	0.485	0.500	0.540	0.605	0.730
0.924	0.25	4.5	0.460	0.488	0.510	0.560	0.630	0.750
0.924	0.25	6.0	0.462	0.490	0.530	0.590	0.675	0.800
0.924	0.25	8.0	0.464	0.500	0.550	0.625	0.730	0.885
0.924	0.25	10.0	0.465	0.510	0.565	0.640	0.760	0.935
0.924	0.50	1.5	0.485	0.490	0.495	0.502	0.535	0.650
0.924	0.50	2.5	0.485	0.492	0.510	0.550	0.605	0.710
0.924	0.50	3.5	0.490	0.510	0.545	0.592	0.675	0.820
0.924	0.50	4.5	0.500	0.530	0.570	0.620	0.710	0.870
0.924	0.50	6.0	0.515	0.550	0.600	0.665	0.760	0.910
0.924	0.50	8.0	0.537	0.580	0.640	0.710	0.815	0.960
0.924	0.50	10.0	0.550	0.610	0.680	0.760	0.870	1.020
0.924	1.00	1.5	0.500	0.500	0.510	0.530	0.570	0.700
0.924	1.00	2.5	0.510	0.520	0.550	0.590	0.660	0.855
0.924	1.00	3.5	0.525	0.553	0.590	0.645	0.745	0.940
0.924	1.00	4.5	0.550	0.580	0.625	0.690	0.800	0.990
0.924	1.00	6.0	0.580	0.620	0.680	0.755	0.875	1.070
0.924	1.00	8.0	0.610	0.665	0.730	0.825	0.960	1.160
0.924	1.00	10.0	0.642	0.700	0.780	0.885	1.030	1.270

TABLE 2. SUBSONIC LIFT CURVE SLOPE PARAMETER, $BC_{L\alpha}/K$

λ	BA/K	$BC_{L\alpha}/K$, per degree Λ_B=0°	Λ_B=15°	Λ_B=30°	Λ_B=45°	Λ_B=60°	Λ_B=75°
0.0	1.5	0.0335	0.0342	0.0348	0.0348	0.0315	0.0225
0.0	2.5	0.0473	0.0484	0.0482	0.0462	0.0395	0.0231
0.0	3.5	0.0574	0.0584	0.0572	0.0525	0.0425	0.0237
0.0	4.5	0.0643	0.0650	0.0628	0.0569	0.0453	0.0244
0.0	6.0	0.0720	0.0727	0.0694	0.0615	0.0475	0.0265
0.0	8.0	0.0787	0.0788	0.0745	0.0645	0.0493	0.0272
0.0	10.0	0.0847	0.0840	0.0780	0.0670	0.0505	0.0278
0.25	1.5	0.0348	0.0350	0.0350	0.0350	0.0315	0.0205
0.25	2.5	0.0498	0.0500	0.0492	0.0465	0.0380	0.0217
0.25	3.5	0.0600	0.0605	0.0585	0.0527	0.0420	0.0229
0.25	4.5	0.0676	0.0673	0.0638	0.0568	0.0439	0.0242
0.25	6.0	0.0760	0.0750	0.0702	0.0610	0.0465	0.0260
0.25	8.0	0.0828	0.0810	0.0750	0.0647	0.0490	0.0268
0.25	10.0	0.0880	0.0860	0.0796	0.0677	0.0505	0.0275
0.50	1.5	0.0350	0.0350	0.0348	0.0338	0.0300	0.0200
0.50	2.5	0.0500	0.0500	0.0484	0.0450	0.0370	0.0209
0.50	3.5	0.0600	0.0598	0.0570	0.0510	0.0400	0.0219
0.50	4.5	0.0679	0.0669	0.0628	0.0546	0.0418	0.0228
0.50	6.0	0.0760	0.0740	0.0680	0.0585	0.0440	0.0236
0.50	8.0	0.0830	0.0800	0.0725	0.0615	0.0450	0.0242
0.50	10.0	0.0878	0.0845	0.0755	0.0630	0.0460	0.0248
1.00	1.5	0.0347	0.0346	0.0340	0.0322	0.0280	0.0185
1.00	2.5	0.0485	0.0480	0.0458	0.0415	0.0340	0.0192
1.00	3.5	0.0582	0.0568	0.0535	0.0475	0.0370	0.0198
1.00	4.5	0.0650	0.0630	0.0584	0.0505	0.0385	0.0205
1.00	6.0	0.0730	0.0702	0.0645	0.0545	0.0405	0.0215
1.00	8.0	0.0795	0.0760	0.0685	0.0575	0.0425	0.0228
1.00	10.0	0.0840	0.0805	0.0732	0.0615	0.0450	0.0240

TABLE 3. FLAP INCREMENTAL SPAN LOADING PARAMETER, $C_\ell C/C_{L\alpha} C_{AV}$

	$C_\ell C/C_{L\alpha} C_{AV}$									
	F=0.1	F=0.2	F=0.3	F=0.4	F=0.5	F=0.6	F=0.7	F=0.8	F=0.9	F=1.0
0.0	0.520	0.788	0.964	1.068	1.120	1.170	1.232	1.240	1.250	1.240
0.1	0.410	0.776	0.970	1.052	1.124	1.176	1.230	1.240	1.250	1.240
0.2	0.216	0.540	0.930	1.008	1.108	1.170	1.200	1.220	1.240	1.220
0.3	0.164	0.336	0.680	0.920	1.040	1.116	1.115	1.118	1.220	1.208
0.4	0.120	0.252	0.424	0.604	0.948	1.028	1.088	1.120	1.170	1.172
0.5	0.084	0.196	0.308	0.400	0.640	0.912	0.990	1.050	1.080	1.092
0.6	0.052	0.140	0.220	0.304	0.430	0.586	0.852	0.940	0.980	1.000
0.7	0.040	0.100	0.160	0.212	0.300	0.396	0.600	0.800	0.864	0.900
0.8	0.040	0.072	0.110	0.150	0.200	0.268	0.350	0.540	0.736	0.768
0.9	0.032	0.052	0.072	0.096	0.120	0.160	0.200	0.280	0.460	0.588
1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NOTE	$F = b_F/b$									

For the supersonic speed regime, data are obtained from Figures 5, 6, 7, and 9 of reference 3 and Figures 5,6,7, and 9 of reference 4 and consists of the variation of the spanwise loading parameter, $(2\Gamma/V\alpha b)$, with the sweep parameter, Bm, for various values of the aspect-ratio parameter, BA, and the taper ratio, λ. These data are presented in Table 4.

The determination of carryover lift reduction due to body-surface interference is not within the capability of this program. However, the user may input estimated reduction factors for each of the lifting surfaces. These reduction factors are applied to the spanwise loading parameter inboard of the body-surface interface station.

Other needed parameters which are stored in the SWEEP program data bank are as follows: The variation of the compressible lift-curve slope correction factor, B/K, is obtained using the section lift curve slope variation with mach number data from Figure 7(b) of reference 5, where

$$B/K = 2\pi/C_{\ell_\alpha} \tag{14}$$

The resulting variation of B/K with mach number is shown in Figure 4.

The variation of the section center of pressure for the lift due to angle of attack, (X/C), is obtained from Figure 22 of reference 6 and is shown in Figure 5.

TABLE 4. SUPERSONIC SPAN LOADING PARAMETER, $2\Gamma/V\alpha b$

η	λ	BA	$2\Gamma/V\alpha b$								
			Bm=0.4	Bm=0.6	Bm=0.8	Bm=1.0	Bm=1.3	Bm=2.0	Bm=3.0	Bm=5.0	Bm=12.0
0.0	0.0	2.0	1.392	1.880	2.256	2.536	2.700	3.050	3.325	3.475	3.675
0.0	0.0	3.0	0.915	1.260	1.500	1.700	1.842	2.056	2.260	2.375	2.520
0.0	0.0	4.0	0.708	0.940	1.130	1.275	1.388	1.536	1.670	1.776	1.900
0.0	0.0	6.0	0.455	0.626	0.758	0.850	0.923	1.026	1.105	1.190	1.270
0.0	0.0	12.0	0.224	0.310	0.378	0.425	0.462	0.515	0.550	0.592	0.633
0.0	0.25	2.0	1.100	1.510	1.810	2.040	2.155	2.295	2.435	2.605	2.760
0.0	0.25	3.0	0.753	1.004	1.200	1.352	1.480	1.650	1.776	1.900	2.020
0.0	0.25	4.0	0.545	0.746	0.902	1.020	1.105	1.235	1.330	1.420	1.515
0.0	0.25	6.0	0.353	0.490	0.600	0.680	0.738	0.825	0.888	0.948	1.008
0.0	0.25	12.0	0.190	0.260	0.310	0.338	0.370	0.410	0.443	0.475	0.510
0.0	0.50	2.0	0.910	1.256	1.510	1.700	1.800	1.910	2.050	2.170	2.330
0.0	0.50	3.0	0.603	0.828	1.005	1.134	1.224	1.372	1.476	1.580	1.685
0.0	0.50	4.0	0.462	0.635	0.755	0.850	0.920	1.025	1.110	1.188	1.260
0.0	0.50	6.0	0.296	0.410	0.503	0.568	0.615	0.686	0.740	0.792	0.840
0.0	0.50	12.0	0.138	0.200	0.255	0.282	0.308	0.343	0.368	0.395	0.420
0.0	1.00	2.0	0.732	0.975	1.150	1.272	1.384	1.540	1.660	1.776	1.895
0.0	1.00	3.0	0.448	0.620	0.752	0.850	0.930	1.030	1.111	1.190	1.255
0.0	1.00	4.0	0.338	0.468	0.570	0.640	0.690	0.770	0.835	0.890	0.935
0.0	1.00	6.0	0.213	0.302	0.373	0.425	0.460	0.514	0.556	0.595	0.630
0.0	1.00	12.0	0.100	0.148	0.188	0.212	0.230	0.258	0.278	0.299	0.312

TABLE 4. SUPERSONIC SPAN LOADING PARAMETER, $2\Gamma/V\alpha b$ (CONT)

η	λ	BA	$2\Gamma/V\alpha b$								
			Bm=0.4	Bm=0.6	Bm=0.8	Bm=1.0	Bm=1.3	Bm=2.0	Bm=3.0	Bm=5.0	Bm=12.0
0.383	0.0	2.0	1.376	1.656	1.852	2.000	2.000	2.000	2.000	2.075	2.125
0.383	0.0	3.0	1.015	1.240	1.360	1.450	1.470	1.510	1.510	1.560	1.575
0.383	0.0	4.0	0.860	1.015	1.114	1.117	1.168	1.198	1.200	1.216	1.229
0.383	0.0	6.0	0.660	0.782	0.846	0.886	0.868	0.850	0.832	0.826	0.824
0.383	0.0	12.0	0.440	0.520	0.552	0.570	0.526	0.472	0.443	0.420	0.416
0.383	0.25	2.0	1.270	1.564	1.745	1.880	2.000	2.107	2.180	2.220	2.260
0.383	0.25	3.0	0.980	1.172	1.290	1.370	1.390	1.420	1.440	1.480	1.490
0.383	0.25	4.0	0.795	0.960	1.054	1.114	1.110	1.112	1.114	1.124	1.122
0.383	0.25	6.0	0.575	0.720	0.805	0.840	0.820	0.792	0.775	0.765	0.760
0.383	0.25	12.0	0.355	0.460	0.520	0.542	0.498	0.438	0.403	0.390	0.380
0.383	0.50	2.0	1.240	1.500	1.670	1.796	1.801	1.812	1.828	1.860	1.900
0.383	0.50	3.0	0.915	1.110	1.236	1.314	1.328	1.344	1.372	1.388	1.400
0.383	0.50	4.0	0.750	0.915	1.015	1.070	1.060	1.060	1.061	1.062	1.076
0.383	0.50	6.0	0.542	0.690	0.780	0.810	0.784	0.755	0.740	0.728	0.719
0.383	0.50	12.0	0.340	0.445	0.511	0.526	0.478	0.415	0.380	0.365	0.360
0.383	1.00	2.0	1.145	1.405	1.580	1.692	1.740	1.774	1.778	1.776	1.772
0.383	1.00	3.0	0.825	1.030	1.170	1.248	1.250	1.263	1.280	1.296	1.310
0.383	1.00	4.0	0.665	0.845	0.960	1.016	1.005	0.998	0.996	0.995	0.995
0.383	1.00	6.0	0.500	0.640	0.730	0.770	0.744	0.712	0.692	0.680	0.670
0.383	1.00	12.0	0.320	0.420	0.482	0.505	0.454	0.385	0.353	0.342	0.335

TABLE 4. SUPERSONIC SPAN LOADING PARAMETER, $2\Gamma/V\alpha b$ (CONT)

η	λ	BA	$2\Gamma/V\alpha b$								
			Bm=0.4	Bm=0.6	Bm=0.8	Bm=1.0	Bm=1.3	Bm=2.0	Bm=3.0	Bm=5.0	Bm=12.0
0.707	0.0	2.0	1.080	1.240	1.320	1.380	1.250	1.140	1.070	1.020	1.010
0.707	0.0	3.0	0.835	0.980	1.032	1.072	0.990	0.892	0.820	0.770	0.765
0.707	0.0	4.0	0.713	0.826	0.876	0.900	0.800	0.700	0.614	0.590	0.588
0.707	0.0	6.0	0.550	0.662	0.700	0.715	0.592	0.450	0.410	0.392	0.388
0.707	0.0	12.0	0.330	0.430	0.482	0.490	0.305	0.225	0.202	0.198	0.194
0.707	0.25	2.0	1.240	1.440	1.448	1.443	1.395	1.325	1.245	1.160	1.065
0.707	0.25	3.0	0.965	1.126	1.202	1.250	1.180	1.080	1.010	0.940	0.890
0.707	0.25	4.0	0.783	0.943	1.012	1.045	0.965	0.860	0.796	0.756	0.735
0.707	0.25	6.0	0.586	0.735	0.804	0.820	0.725	0.580	0.530	0.508	0.505
0.707	0.25	12.0	0.355	0.470	0.540	0.560	0.390	0.287	0.264	0.255	0.252
0.707	0.05	2.0	1.380	1.448	1.479	1.470	1.400	1.320	1.245	1.160	1.110
0.707	0.50	3.0	1.010	1.210	1.308	1.364	1.268	1.180	1.100	1.028	0.970
0.707	0.50	4.0	0.800	0.995	1.100	1.135	1.060	0.975	0.902	0.850	0.807
0.707	0.50	6.0	0.585	0.760	0.860	0.890	0.796	0.664	0.608	0.585	0.578
0.707	0.50	12.0	0.400	0.512	0.580	0.602	0.450	0.330	0.302	0.292	0.288
0.707	1.00	2.0	1.390	1.490	1.520	1.512	1.480	1.448	1.422	1.380	1.325
0.707	1.00	3.0	1.143	1.335	1.412	1.404	1.350	1.252	1.186	1.125	1.073
0.707	1.00	4.0	0.880	1.093	1.215	1.250	1.185	1.085	1.005	0.942	0.895
0.707	1.00	6.0	0.622	0.813	0.930	0.980	0.888	0.770	0.705	0.680	0.668
0.707	1.00	12.0	0.390	0.525	0.615	0.654	0.520	0.385	0.352	0.342	0.335

TABLE 4. SUPERSONIC SPAN LOADING PARAMETER, $2\Gamma/V\alpha b$ (CONCL)

η	λ	BA	$2\Gamma/V\alpha b$								
			Bm=0.4	Bm=0.6	Bm=0.8	Bm=1.0	Bm=1.3	Bm=2.0	Bm=3.0	Bm=5.0	Bm=12.0
0.924	0.0	2.0	0.596	0.652	0.696	0.708	0.425	0.300	0.270	0.270	0.270
0.924	0.0	3.0	0.495	0.532	0.556	0.560	0.320	0.230	0.205	0.205	0.205
0.924	0.0	4.0	0.432	0.464	0.480	0.480	0.246	0.180	0.160	0.160	0.160
0.924	0.0	6.0	0.310	0.375	0.387	0.390	0.158	0.118	0.108	0.100	0.100
0.924	0.0	12.0	0.202	0.356	0.275	0.275	0.080	0.060	0.057	0.050	0.050
0.924	0.25	2.0	0.810	0.794	0.780	0.760	0.725	0.635	0.533	0.490	0.450
0.924	0.25	3.0	0.800	0.790	0.770	0.730	0.692	0.536	0.464	0.424	0.395
0.924	0.25	4.0	0.790	0.780	0.752	0.720	0.635	0.450	0.400	0.366	0.347
0.924	0.25	6.0	0.555	0.670	0.716	0.700	0.490	0.340	0.305	0.280	0.270
0.924	0.25	12.0	0.350	0.445	0.495	0.505	0.255	0.190	0.172	0.167	0.161
0.924	0.50	2.0	0.805	0.805	0.803	0.800	0.790	0.758	0.664	0.585	0.545
0.924	0.50	3.0	0.785	0.785	0.780	0.760	0.703	0.640	0.564	0.510	0.478
0.924	0.50	4.0	0.765	0.765	0.755	0.735	0.660	0.550	0.485	0.450	0.421
0.924	0.50	6.0	0.740	0.740	0.730	0.710	0.590	0.442	0.383	0.355	0.331
0.924	0.50	12.0	0.430	0.550	0.615	0.635	0.375	0.273	0.244	0.228	0.220
0.925	1.00	2.0	0.840	0.840	0.840	0.840	0.825	0.822	0.805	0.744	0.712
0.924	1.00	3.0	0.795	0.795	0.795	0.795	0.775	0.745	0.685	0.630	0.597
0.924	1.00	4.0	0.760	0.760	0.760	0.760	0.748	0.670	0.584	0.540	0.505
0.924	1.00	6.0	0.740	0.740	0.740	0.740	0.700	0.540	0.470	0.430	0.400
0.924	1.00	12.0	0.710	0.710	0.710	0.710	0.500	0.352	0.310	0.285	0.270

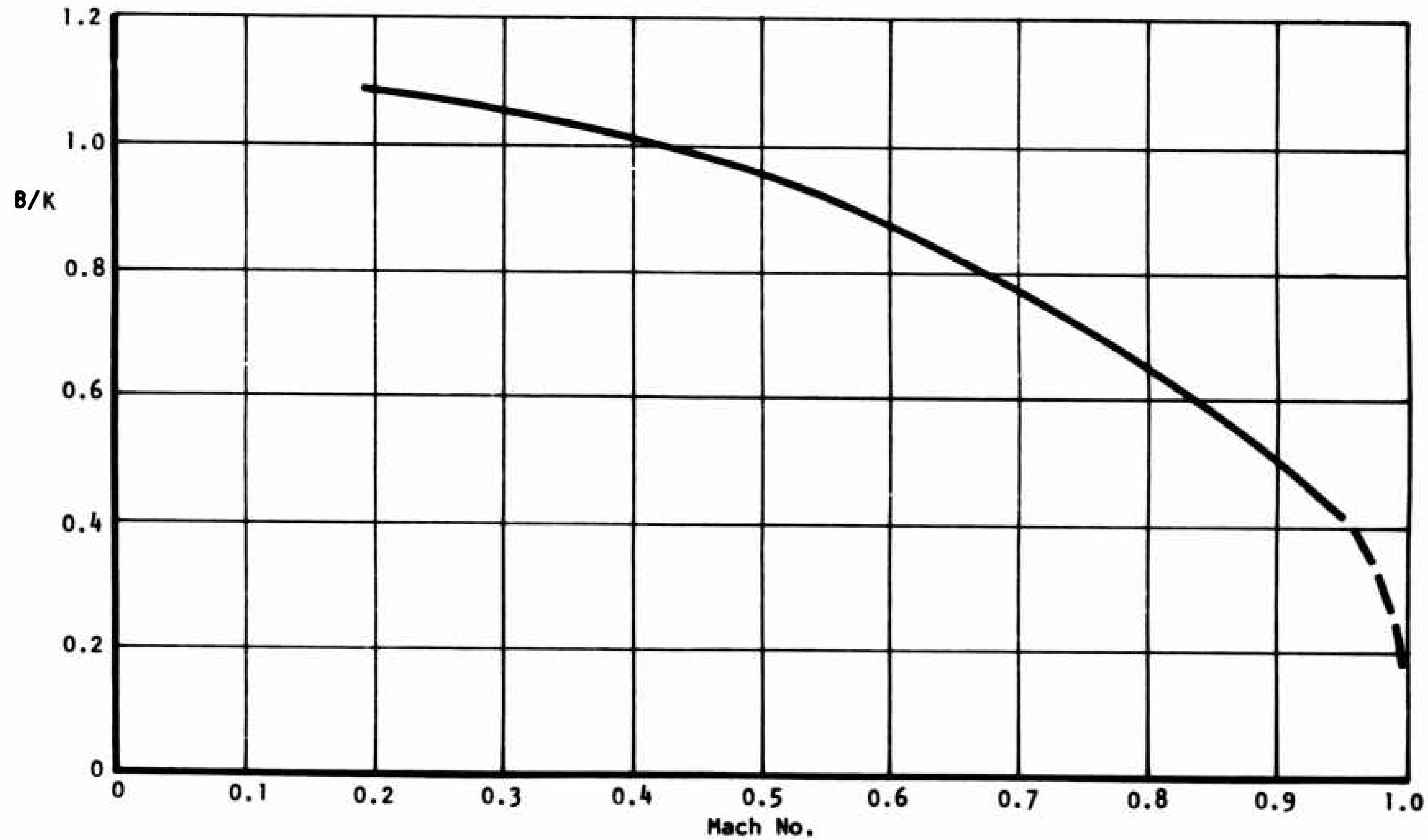


Figure 4. Variation of section lift curve slope correction factor, B/K, with mach number.

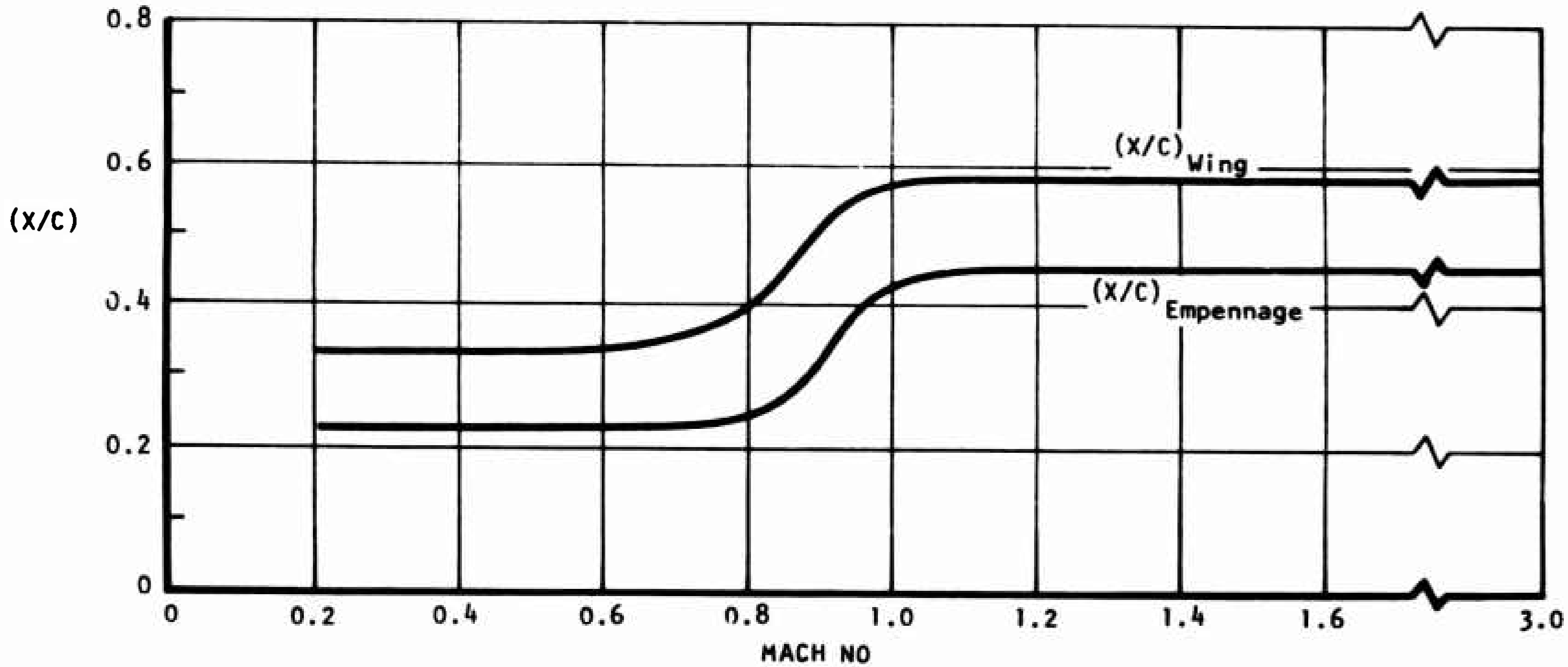


Figure 5. Variation of section center of pressure, X/C, with mach number for wing and empennage.

The variation of the section center of pressure for the lift due to wing flap deflection, $(X/C)_F$, is obtained from references 7, 8, and 9 and is shown in Figure 6.

LIFTING SURFACE GEOMETRY

The lifting surface geometry used is based on the theoretical (trapezoidal) platform as shown in Figure 1 for the wing or horizontal tail. The span stations Y_{FI} and Y_{FO} for the inboard and outboard ends of the wing flap apply to the wing only.

Figure 2 shows the vertical tail geometry used in the determination of the unit airload data. For the conventional (non-T-type) empennage with the horizontal tail mounted on the body, the dimension Z_{BI} is measured from the Z station of horizontal tail root to the top of the body. For the T-type empennage, the dimension Z_{BI} is measured from the center of the body to the top of the body.

WING AND HORIZONTAL TAIL UNIT AIRLOAD DISTRIBUTIONS

The following methods for the determination of airload shear and moments versus span and the centers of pressure of the exposed panel and body carry-over loads are applicable to the wing and horizontal tail.

UNIT AIRLOAD SHEAR DUE TO ANGLE OF ATTACK, SUBSONIC

$$\text{Calculate } B = \left(1 - M^2\right)^{1/2} \tag{15}$$

$$\text{Calculate } \Lambda_B = \text{Arctan}\left(\frac{\tan \Lambda_{0.25c}}{B}\right)$$

$$= \text{Arctan}\left\{\frac{1}{B}\left[\tan \Lambda_E - \frac{1}{A}\left(\frac{1 - \lambda}{1 + \lambda}\right)\right]\right\} \tag{16}$$

Interpolate the B/K versus M data bank data of Figure 4 to obtain B/K for the given Mach number.

$$\text{Calculate } BA/K = A(B/K) \tag{16a}$$

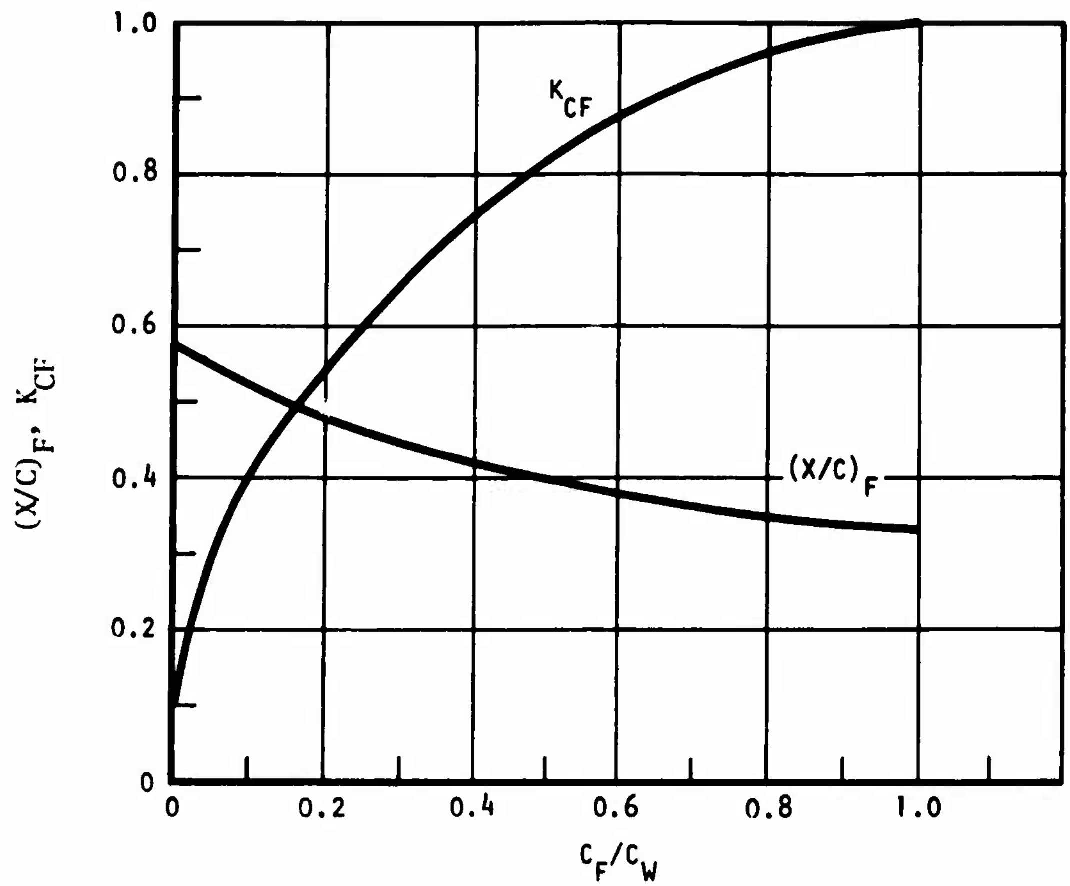


Figure 6. Variation of flap lift effectiveness, K_{CF}, and flap lift center-of-pressure, $(X/C)_F$, with flap chord ratio, C_F/C_W.

Using BA/K, Λ_B, and λ, interpolate the subsonic $(C_\ell C/C_L C_{AV})$ data bank data of Table 1 to obtain $(C_\ell C/C_L C_{AV})$ values at the selected η stations. Carryover lift reduction factor (K_{co}) is obtained from the input data set. This factor defines a transition in the spanwise loading parameter at the side of body station (η_{BI}). Should the input value be zero, the program default assumes an undisturbed spanwise loading parameter $(K_{co} = 1.0)$.

The normalized spanwise loading parameter at the η stations at and outboard of the side of body is defined by equation 17. Normalized spanwise loading parameter at and inboard of the side of body is defined by equation 17a.

$$\left(\frac{C_\ell' C}{C_L C_{AV}}\right)_\eta = \left[\frac{C_\ell C}{C_L C_{AV}}\right]_\eta \div \left[\int_{\eta=\eta_{BI}}^{1} \left(\frac{C_\ell C}{C_L C_{AV}}\right) d\eta + K_{co} \int_{\eta=0}^{\eta=\eta_{BI}} \left(\frac{C_\ell C}{C_L C_{AV}}\right) d\eta\right] \qquad (17)$$

$$\left(\frac{C_\ell' C}{C_L C_{AV}}\right)_\eta = K_{co} \left[\frac{C_\ell C}{C_L C_{AV}}\right]_\eta \div \left[\int_{\eta=\eta_{BI}}^{1} \left(\frac{C_\ell C}{C_L C_{AV}}\right) d\eta + K_{co} \int_{\eta=0}^{\eta=\eta_{BI}} \left(\frac{C_\ell C}{C_L C_{AV}}\right) d\right] \qquad (17a)$$

Equations 17 and 17a define two values for the normalized spanwise loading parameter at the side of body station. These values are used as limits when integrating load within segments immediately outboard or inboard of the side of body, respectively. The unit airload shear due to angle attack is then

$$USZA_\eta = \int_\eta^1 \left(\frac{C_\ell' C}{C_L C_{AV}}\right) d\eta \tag{18}$$

Using BA/K, Λ_B, and λ, interpolate $(BC_{L\alpha}/K)$ data bank data of Table 2 to obtain the lift-curve slope parameter, $(BC_{L\alpha}/K)$. Lift curve slope, adjusted for carry-over lift reduction is then calculated by equation 19.

$$C_{L\alpha} = \frac{57.3\ (BC_{L\alpha}/K)}{(B/K)} \left[\frac{\displaystyle\int_{\eta=\eta_{BI}}^{1} \left(\frac{C_\ell C}{C_L C_{AV}}\right) d\eta + K_{co} \int_{\eta=0}^{\eta=\eta_{BI}} \left(\frac{C_\ell C}{C_L C_{AV}}\right) d\eta}{\displaystyle\int_{\eta=0}^{\eta=1} \left(\frac{C_\ell C}{C_L C_{AV}}\right) d\eta} \right], \tag{19}$$

per radian

UNIT AIRLOAD SHEAR DUE TO ANGLE OF ATTACK, SUPERSONIC

$$\text{Calculate} \quad B = \left(M^2 - 1\right)^{1/2} \tag{20}$$

$$Bm = B \cot \Lambda_E \tag{21}$$

$$BA = B \cdot A$$

Using BA, Bm, and λ, interpolate the $(2\Gamma/V\alpha b)$ data bank data of Table 4 to obtain the $(2\Gamma/V\alpha b)$ values at the selected η stations. Carryover lift reduction factor (K_{co}) is used in the same manner as for subsonic flight.

$$\text{Calculate } C_{L\alpha}/A = \int_{\eta=\eta_{BI}}^{1} \left(\frac{2\Gamma}{V\alpha b}\right) d\eta + K_{co} \int_{\eta=0}^{\eta=\eta_{BI}} \left(\frac{2\Gamma}{V\alpha V}\right) d\eta \tag{22}$$

$$\text{Calculate } C_{L\alpha} = A(C_{L\alpha}/A), \text{ per radian} \tag{23}$$

The normalized spanwise loading parameter at and outboard of the side of body is defined by equation 24 and, for η stations at and inboard of the side of body, by equation 25.

$$\left(\frac{C'_\ell C}{C_L C_{AV}}\right)_\eta = \frac{A}{C_{L\alpha}} \left(\frac{2\Gamma}{V\alpha b}\right)_\eta \tag{24}$$

$$\left(\frac{C'_\ell C}{C_L C_{AV}}\right)_\eta = \frac{A}{C_{L\alpha}} K_{co} \left(\frac{2\Gamma}{V\alpha b}\right)_\eta \tag{25}$$

Calculate the unit airload shear due to angle of attack as follows:

$$USZA_{\eta} = \int_{\eta}^{1} \left(\frac{C_{\ell}'C}{C_L C_{AV}}\right) d\eta \tag{26}$$

UNIT AIRLOAD SHEAR DUE TO WING FLAP DEFLECTION

Calculate $(b_{FO}/b) = Y_{FO}/(b/2)$ (27)

$$(b_{FI}/b) = Y_{FI}/(b/2) \tag{28}$$

Interpolate the $(C_{\ell}C/C_{L\alpha}C_{AV})$ data bank data of Table 3 to obtain the $(C_{\ell}C/C_{L\alpha}C_{AV})$ values at the selected η values for the (b_{FO}/b) and (b_{FI}/b) wing flap span ratios.

Calculate the flap span normalizing parameter, K_{BF}, as follows:

$$K_{BF} = \int_{\eta=\eta_{BI}}^{1} \left[\left(\frac{C_{\ell}C}{C_{L\alpha}C_{AV}}\right)_{b_{FO}/b} - \left(\frac{C_{\ell}C}{C_{L\alpha}C_{AV}}\right)_{b_{FI}/b}\right] d\eta$$

$$+ K_{CO} \int_{\eta=0}^{\eta=\eta_{BI}} \left[\left(\frac{C_{\ell}C}{C_{L\alpha}C_{AV}}\right)_{b_{FO}/b} - \left(\frac{C_{\ell}C}{C_{L\alpha}C_{AV}}\right)_{b_{FI}/b}\right] d\eta \tag{29}$$

The normalized spanwise loading parameter at η stations at and outboard of the side of body is then defined by equation 30 and, for η stations at and inboard of the side of body, by equation 30a.

$$\left(\frac{\Delta C_\ell' C}{C_{L\alpha} C_{AV}}\right)_\eta = \frac{1}{K_{BF}} \left[\left(\frac{C_\ell C}{C_{L\alpha} C_{AV}}\right)_{b_{FO}/b} - \left(\frac{C_\ell C}{C_{L\alpha} C_{AV}}\right)_{b_{FI}/b} \right]_\eta \tag{30}$$

$$\left(\frac{\Delta C_\ell' C}{C_{L\alpha} C_{AV}}\right)_\eta = \frac{K_{CO}}{K_{BF}} \left[\left(\frac{C_\ell C}{C_{L\alpha} C_{AV}}\right)_{b_{FO}/b} - \left(\frac{C_\ell C}{C_{L\alpha} C_{AV}}\right)_{b_{FI}/b} \right]_\eta \tag{30a}$$

The unit airload shear, $USZF_\eta$, due to wing flap deflection is then obtained as follows:

$$USZF_\eta = \int_\eta^1 \left(\frac{\Delta C_\ell' C}{C_{L\alpha} C_{AV}}\right) d\eta \tag{31}$$

UNIT AIRLOAD BENDING MOMENTS

The unit bending moments due to angle of attach and due to wing flap deflection are obtained as follows, using equation 2:

$$UMXA_{\eta} = \frac{b}{2\cos\Lambda_R} \int_{\eta}^{1} USZA \, d\eta \tag{32}$$

$$UMXF_{\eta} = \frac{b}{2\cos\Lambda_R} \int_{\eta}^{1} USZF \, d\eta \tag{33}$$

UNIT AIRLOAD TORSIONAL MOMENTS

The unit torsional moment about the load reference line for the lift due to angle of attack is determined as follows, using equation 3:

$$UMYA_{\eta} = - \int_{\eta}^{1} \left(\frac{C_{\ell}'C}{C_L C_{AV}}\right)_{\eta} \Delta X_{\Lambda\eta} \, d\eta \tag{34}$$

where

$\left(\frac{C_{\ell}'C}{C_L C_{AV}}\right)_{\eta}$ is obtained from equations 17 or 17a for subsonic speeds and from equations 24 or 25 for supersonic speeds.

$\Delta X_{\Lambda\eta}$ is the normal distance from the load reference line to the local center of pressure at station η, and is positive when center of pressure is aft of load reference line.

$\Delta X_{\Lambda\eta}$ is determined as follows:

when $\eta \geq \eta_{BI}$:

$$\Delta X_{\Lambda\eta} = C_{\Lambda\eta} \left[(X_{\Lambda}/C_{\Lambda})_{CP} - (X_{\Lambda}/C_{\Lambda})_R\right] \tag{35}$$

where

$$C_{\Lambda\eta} = \frac{[1 - \eta\ (1 - \lambda)]\ C_R \cos\Lambda_R}{1 - K_\Lambda\,[1 - (X/C)_R - (X_\Lambda/C_\Lambda)_R]} \tag{36}$$

$$K_\Lambda = \frac{4}{A}\left(\frac{1 - \lambda}{1 + \lambda}\right)(\sin\Lambda_R \cos\Lambda_R) \tag{37}$$

$$(X_\Lambda/C_\Lambda)_R = (X/C)_R\left\{1 - K_\Lambda[1 - (X/C)_R]\right\} \tag{38}$$

$$(X_\Lambda/C_\Lambda)_{CP} = (X/C)_{CP}\left\{1 - K_\Lambda[1 - (X/C)_{CP}]\right\} \tag{39}$$

$(X/C)_R$ is the given value of X/C for the load reference line.

$(X/C)_{CP}$ is the section center of pressure for the lift due to angle of attack, X/C, and is obtained by interpolation of the (X/C) versus mach number data bank data of Figure 5.

when $\eta \geq \eta_{BI}$: the center of pressure is assumed to be at a constant fuselage station equal to the center-of-pressure location at the body side. Then,

$$\Delta X_{\Lambda\eta} = \Delta X_{\Lambda\eta_{BI}} + (\eta_{BI} - \eta)\left(\frac{b}{2}\right)\sin\Lambda_R \tag{40}$$

The unit torsional moment about the load reference line for the lift due to wing flap deflection is determined as follows, using equation 3:

$$UMYF = -\int_{\eta}^{1}\left(\frac{\Delta C_l' C}{C_{L\alpha} C_{AV}}\right)\Delta X_\Lambda\, d\eta \tag{41}$$

where

$\left(\frac{\Delta C_l' C}{C_{L\alpha} C_{AV}}\right)$ is obtained from equations 30 or 30a and ΔX_Λ is determined using equations 35 through 39 except that $(X/C)_{CP}$ is obtained from interpolation of the $(X/C)_F$ versus (C_F/C_W) data bank data of Figure 6.

GROSS SURFACE UNIT AIRLOADS

The values of the unit shears and moments at the surface's theoretical root station, $\eta = 0$, corresponds to the total surface values per side. The values of the unit shears and moments at the side of the body station, $\eta = \eta_{BI}$, corresponds to the exposed surface values per side. The values for the carry-over on the body are equal to the total surface values minus the values at the body side. The symbol S is used for the total surface values, S(B) is used for the exposed surface values, and B(S) is used for the carry-over values. The values of unit loads and moments are as follows.

- For lift due to angle-of-attack:

USZAS = 1.0 = Unit airload on total surface per side. Equal to USZA from equation 18 or 26 for $\eta = 0$.

USZA(SOB) = Unit airload on exposed surface per side. Equal to USZA from equation 18 or 26 for $\eta = \eta_{BI}$.

USZAB(S) = Unit carry-over airload on body per side

$$= 1 - (\text{USZA(SOB)}) \tag{42}$$

UMXAS = Unit airload bending moment at $\eta = 0$. Equal to UMXA from equation 32 for $\eta = 0$.

UMXAS(B) = Unit airload bending moment at $\eta = \eta_{BI}$. Equal to UMXA from equation 32 for $\eta = \eta_{BI}$.

UMYAS = Unit airload torsional moment per side at $\eta = 0$. Equal to UMYA from equation 34 at $\eta = 0$.

UMYAS(B) = Unit airload torsional moment at $\eta = \eta_{BI}$. Equal to UMYA from equation 34 at $\eta = \eta_{BI}$.

UMXA(SOB) = Exposed panel unit rolling moment at the side of the body.

$$= (\text{UMXAS(B)}) \cos \Lambda_R + (\text{UMYAS(B)}) \sin \Lambda_R. \tag{43}$$

UMYA(SOB) = Exposed panel unit pitching moment (per side) at the intersection of the load reference line and the side of the body station Y_{BI}.

$$= (UMYAS(B)) \cos \Lambda_R - (UMXAS(B)) \sin \Lambda_R \tag{44}$$

- For lift due to wing flap deflection:

USZFS = 1.0 = Unit airload on total surface per side. Equal to USZF from equation 31 for $\eta = 0$.

USZF(SOB) = Unit airload on exposed surface per side. Equal to USZF from equation 31 for $\eta = \eta_{BI}$.

USZFB(S) = Unit carry-over airload on body per side.

$$= 1 - (USZF(SOB)) \tag{45}$$

UMXFS = Unit airload bending moment at $\eta = 0$. Equal to UMXF from equation 33 for $\eta = 0$.

UMXFS(B) = Unit airload bending moment at $\eta = \eta_{BI}$. Equal to UMXF from equation 33 for $\eta = \eta_{BI}$.

UMYFS = Unit airload torsional moment at $\eta = 0$. Equal to UMYF from equation 41 for $\eta = 0$.

UMYFS(B) = Unit airload torsional moment at $\eta = \eta_{BI}$. Equal to UMYF from equation 41 for $\eta = \eta_{BI}$.

UMXF(SOB) = Exposed panel unit rolling moment at side of the body

$$= (UMXFS(B)) \cos \Lambda_R + (UMYFS(B)) \sin \Lambda_R \tag{46}$$

UMYF(SOB) = Exposed panel unit pitching moment (per side) at the intersection of the load reference line and the side of the body station, Y_{BI}.

$$= (UMYFS(B)) \cos \Lambda_R - (UMXFS(B)) \sin \Lambda_R \tag{47}$$

NOTE For the horizontal tail, only the lift due to angle-of-attack data is computed.

GROSS SURFACE CENTERS OF PRESSURE

The surface unit airload centers of pressure are $\bar{Y}$ and $\Delta\bar{X}$, where $\bar{Y}$ is the normal distance outboard of the plane of symmetry and $\Delta\bar{X}$ is the distance aft of the surface apex. Subscripts S, S(B), and B(S) denote total surface, exposed surface, and surface carry-over, respectively. Subscripts A and F denote angle-of-attack and flap effects, respectively.

- For lift due to angle of attack:

$$\bar{Y}_{AS} = (\text{UMXAS}) \cos \Lambda_R + (\text{UMYAS}) \sin \Lambda_R \tag{48}$$

$$\bar{Y}_{AS(B)} = Y_{BI} + (\text{UMXA(SOB)})/(\text{USZA(SOB)}) \tag{49}$$

$$\Delta\bar{X}_{AS} = C_R \left(\frac{X}{C}\right)_R - \left[(\text{UMYAS}) \cos \Lambda_R - (\text{UMXAS}) \sin \Lambda_R\right] \tag{50}$$

$$\Delta\bar{X}_{AS(B)} = C_R \left(\frac{X}{C}\right)_R + Y_{BI} \tan \Lambda_R - (\text{UMYA(SOB)})/(\text{USZA(SOB)}) \tag{51}$$

$$\Delta\bar{X}_{AB(S)} = [\Delta\bar{X}_{AS} - \Delta\bar{X}_{AS(B)} \; (\text{USZA(SOB)})] \div [1 - (\text{USZA(SOB)})] \tag{52}$$

- For lift due to wing flap deflection:

$$\bar{Y}_{FS} = (\text{UMXFS}) \cos \Lambda_R + (\text{UMYFS}) \sin \Lambda_R \tag{53}$$

$$\bar{Y}_{FS(B)} = Y_{BI} + (UMXF(SOB))/(USZF(SOB)) \tag{54}$$

$$\Delta X_{FS} = C_R \left(\frac{X}{C}\right)_R - \left[(UMYFS)\cos\Lambda_R - (UMXFS)\sin\Lambda_R\right] \tag{55}$$

$$\Delta\bar{X}_{FS(B)} = C_R \left(\frac{X}{C}\right)_R + Y_{BI}\tan\Lambda_R - (UMYF(SOB))/(USZF(SOB)) \tag{56}$$

$$\Delta\bar{X}_{FB(S)} = [\Delta\bar{X}_{FS} - \Delta\bar{X}_{FS(B)}\ (USZF(SOB))] \div [1 - (USZF(SOB))] \tag{57}$$

NOTE For the horizontal tail, only the lift due to angle-of-attack centers of pressure are computed.

VERTICAL TAIL UNIT AIRLOAD DISTRIBUTIONS

Vertical tail unit airload distributions are determined for two basic types of surfaces:

1. The conventional (non-T-type) surface

2. The T-type vertical tail surface

CONVENTIONAL (NON-T-TYPE) VERTICAL TAIL UNIT AIRLOADS

The method used to determine the unit airload data is the same as that used for the lift due to angle of attack for the wing or horizontal tail, except an effective aspect ratio is used and the surface is considered in the X-Z plane.

The effective aspect ratio for the surface is considered to be twice the geometric aspect ratio (this arbitrarily assumes that the horizontal tail or body serves as a reflection plane), i.e.:

$$A_E = 2\,A_V = 2\left(b_V^2/S_V\right) \tag{58}$$

The unit airload shear at the selected η stations and the surface lift curve slope are determined using equations 15 through 19 for the subsonic case and equations 20 through 26 for the supersonic case, with A_E used in place of A. The unit shear at the selected η stations is then,

$$USYV_\eta = \int_\eta^1 \left(\frac{C_l'C}{C_L C_{AV}}\right) d\eta \tag{59}$$

The unit airload bending moment is determined at the selected stations as follows:

$$UMXV_\eta = \frac{b_V}{\cos \Lambda_R} \int_\eta^1 (USYV)\, d\eta \tag{60}$$

The unit airload torsional moment is determined at the selected stations as follows:

$$UMZV_\eta = - \int_\eta^1 \left(\frac{C_l'C}{C_L C_{AV}}\right) \Delta X_\Lambda\, d\eta \tag{61}$$

where ΔX is determined using equations 34 through 39 and the previously determined $(C_l C/C_L C_{AV})$ from equations 17 or 17a for subsonic speed and equations 24 or 25 for supersonic speeds.

T-TYPE VERTICAL TAIL UNIT AIRLOADS

The methods used to determine the unit airload data for the T-type vertical tail is the same as that used for the conventional vertical tail, except that the spanwise loading parameter is arbitrarily adjusted to account for the end-plate effect of the horizontal tail. This is accomplished by assuming that the vertical tail tip station $\eta_V = 1.0$ is at 0.707 of span for the precalculated span load data in Tables 1 and 4.

GROSS SURFACE UNIT AIRLOADS AND CENTERS OF PRESSURE

The value of the unit shears and moments at the surface's theoretical root station, $\eta = 0$, corresponds to the total surface unit values. The values at the body mold-line station, $\eta = \eta_{BI}$, correspond to the exposed surface total unit values. The symbol VT is used for the total surface values, and V(B) is used for the exposed surface values. The value of unit loads are as follows:

USYVT = 1.0 = Unit airload on total surface. Equal to the value of USYV from equation 59 at $\eta = 0$.

USYV(SOB) = Unit airload on exposed surface. Equal to the value of USYV from equation 59 at $\eta = \eta_{BI}$.

UMXVT = Unit airload bending moment at $\eta = 0$. Equal to the value of UMXV from equation 60 at $\eta = 0$.

UMXV(B) = Unit airload bending moment at body mold line. Equal to the value of UMXV from equation 60 at $\eta = \eta_{BI}$.

UMZVT = Unit airload torsional moment at $\eta = 0$. Equal to the value of UMZV from equation 61 at $\eta = 0$.

UMZV(B) = Unit airload torsional moment at the body mold line. Equal to the value of UMZV from equation 61 at $\eta = \eta_{BI}$.

UMXV(SOB) = Exposed panel unit rolling moment at the body mold line station Z_{BI}.

$$= \text{UMXV(B)} \cdot \cos \Lambda_R + \text{UMZV(B)} \cdot \sin \Lambda_R \qquad (62)$$

UMZV(SOB) = Exposed panel unit yawing moment at the intersection of the load reference line and the body mold line station, η_{BI}.

$$= \text{UMZV(B)} \cdot \cos \Lambda_R - \text{UMXV(B)} \cdot \sin \Lambda_R \qquad (63)$$

The center of pressure of the vertical tail unit airload on the total surface is located at:

$$\bar{Z}_{VT} = \text{UMXVT} \cdot \cos \Lambda_R + \text{UMZVT} \cdot \sin \Lambda_R \qquad (64)$$

$$\Delta \bar{X}_{VT} = C_R \left(\frac{X}{C}\right)_R - [\text{UMZVT} \cdot \cos \Lambda_R - \text{UMXVT} \cdot \sin \Lambda_R] \qquad (65)$$

where $\bar{Z}_{VT}$ is the distance above the vertical tail theoretical root chord, and $\Delta\bar{X}_{VT}$ is the distance aft of the theoretical apex.

DETERMINATION OF LIMIT AIRLOADS ON COMPONENTS

The gross limit airloads on the airplane components and airplane inertia factors are determined for the following specific types of flight conditions:

1. Balanced maneuver at positive limit load factor
2. Balanced maneuver at negative limit load factor
3. Positive 50 fps vertical gust at M_H
4. Negative 50 fps vertical gust at M_H
5. Lateral 50 fps gust at M_H
6. Pitching acceleration at 0.5 maximum positive limit load factor at M_L
7. Arbitrary yawing acceleration at M_L
8. Flaps-down balanced maneuver at maximum limit positive flaps-down load factor at V_F
9. Flaps-down 1.0 g trim for landing approach at 1.2 V_{S_L}

The design limit load factors, pitching and yawing accelerations, gross weights, center-of-gravity positions, speed-altitude combinations, and geometric data are considered as input data. (Refer to Table 23.)

BALANCED MANEUVER CONDITION

The balanced maneuver condition is a flight condition in which the aircraft is trimmed (balanced) at a specific load factor. The following procedures are used to determine the limit airloads on the wing, body, and empennage. The incremental airloads due to wing flap extension are determined only for the subsonic flaps-down conditions.

The wing lift is composed of the lift due to angle of attack and the incremental lift due to wing flap deflection, i.e.:

$$C_{LW} = C_{LWA} + \Delta C_{LF} \tag{66}$$

The wing lift is initially estimated to be

$$C_{LWO} = 1.1 \left(\frac{N_Z W}{q\ S_W}\right) \tag{67}$$

where n_Z is the limit load factor specified for the condition.

The incremental wing lift due to wing flap deflection is initially estimated to be:

$$\Delta C_{LFO} = \left(\frac{\delta F}{57.3}\right) K_{CF}\ K_{BF}\ C_{L\alpha W} \tag{68}$$

where

δF = flap deflection in degrees

K_{CF} = $(dC_L/d\delta_F)/(dC_L/d\alpha)$ and is obtained by interpolation the K_{CF} versus C_F/C data bank data of Figure 6 which is obtained from Figure 21 of reference 10.

K_{BF} is obtained from equation 29.

$C_{L\alpha W}$ is obtained from equation 19 or 23.

The initially estimated wing lift due to angle of attack is then

$$C_{LWAO} = C_{LWO} - \Delta C_{LFO} \tag{69}$$

and angle of attack is estimated to be:

$$\alpha_0 = C_{LWAO}/C_{L\alpha W} \tag{70}$$

The initially estimated airplane component limit loads for a trimmed condition are then determined as follows.

P_{ZNO} = body nose load

$$= \alpha_0 \, 2\pi R_N^2 \, q/144 \tag{71}$$

$$= 0.043633 \, \alpha_0 \, R_N^2 \, q \tag{72}$$

where R_N = maximum nose radius (in.). Equation 71 is the same as equation 3 of reference 11.

The exposed wing limit airloads due to angle of attack and due to flap deflection are:

$$P_{ZW(B)AO} = (USZA(SOB)) \; C_{LWAO} \; q \; S_W \tag{73}$$

$$P_{ZW(B)FO} = (USZF(SOB)) \; \Delta C_{LFO} \; q \; S_W \tag{74}$$

The wing carry-over limit airloads on the body are:

$$P_{ZB(W)AO} = (USZAB(W)) \; C_{LWAO} \; q \; S_W \tag{75}$$

$$P_{ZB(W)FO} = (USZFB(W)) \; \Delta C_{LFO} \; q \; S_W \tag{76}$$

where USZAB(W) and USZFB(W) are obtained from equations 42 and 45.

The balancing horizontal tail (or canard) limit airload is then,

$$\begin{aligned} P_{ZHO} = \; & [(X_{CG} - \bar{X}_N) \, P_{ZNO} + (X_{CG} - \bar{X}_{W(B)A}) \, P_{ZW(B)AO} \\ & + (X_{CG} - \bar{X}_{W(B)F}) \, P_{ZW(B)FO} + (X_{CG} - \bar{X}_{B(W)A}) \, P_{ZB(W)AO} \\ & + (X_{CG} - \bar{X}_{B(W)F}) P_{ZB(W)FO}] + [\bar{X}_H - X_{CG}] \end{aligned} \tag{77}$$

where

$$\bar{X}_N = X_0 + \ell_N - \frac{V_N}{\pi R_N^2} \tag{78}$$

$$\bar{X}_{W(B)A} = X_{WE} + \Delta\bar{X}_{W(B)A} \tag{79}$$

$$\bar{X}_{W(B)F} = X_{WE} + \Delta\bar{X}_{W(B)F} \tag{80}$$

$$\bar{X}_{B(W)A} = X_{WE} + \bar{X}_{B(W)A} \tag{81}$$

$$\bar{X}_{B(W)F} = X_{WE} + \Delta\bar{X}_{B(W)F} \tag{82}$$

$$\bar{X}_H = X_{HE} + \Delta\bar{X}_H \tag{83}$$

X_0 = Fuselage station at body nose, in.

ℓ_N = Nose length, in.

V_N = Nose volume, cu in.

X_{WE} = Fuselage station of wing apex, in.

X_{HE} = Fuselage station of horizontal tail apex, in.

$\Delta\bar{X}_{W(B)A}$, $\Delta\bar{X}_{W(B)F}$, $\Delta\bar{X}_{B(W)A}$, $\Delta\bar{X}_{B(W)F}$ and $\Delta\bar{X}_H$ are from equations 51, 56, 52, 57, and 50, respectively.

The term,

$$\left(\ell_N - \frac{V_N}{\pi R_N^2}\right)$$

is the distance aft of the body nose to the center of pressure of the body nose load and is the same as equation 33 of reference 11.

The total airplane normal airload for the initially estimated condition is equal to the sum of the component loads

$$P_{ZAO} = \sum P_{ZO} = P_{ZNO} + P_{ZW(B)A} + P_{ZW(B)F}$$

$$+ P_{ZB(W)A} + P_{ZB(W)F} + P_{ZHO} \tag{84}$$

The final component airloads for the balanced maneuver condition are then equal to the initially estimated airloads multiplied by the ratio of the required airload, $N_Z W$, to the estimated total airload, P_{ZAO}.

Let

$$K_Z = \frac{N_Z W}{P_{ZAO}} \tag{85}$$

then

$$P_{ZW(B)A} = K_Z \cdot P_{ZW(B)AO} \tag{86}$$

$$P_{ZW(B)F} = K_Z \cdot P_{ZW(B)FO} \tag{87}$$

$$P_{ZB(W)} = K_Z \, (P_{ZB(W)AO} + P_{ZB(W)FO}) \tag{88}$$

$$P_{ZH} = K_Z \cdot P_{ZHO} \tag{89}$$

$$P_{ZN} = K_Z \cdot P_{ZNO} \tag{90}$$

$$P_{ZW(B)} = P_{ZW(B)A} + P_{ZW(B)F} \tag{91}$$

$$\bar{X}_{W(B)} = \left(\frac{\bar{X}_{W(B)A} \cdot P_{ZW(B)A} + \bar{X}_{W(B)F} \cdot P_{ZW(B)F}}{P_{ZW(B)}} \right) \tag{92}$$

$$\bar{X}_{B(W)} = \left(\frac{\bar{X}_{B(W)A} \cdot P_{ZB(W)A} + \bar{X}_{B(W)F} \cdot P_{ZB(W)F}}{P_{ZB(W)}} \right) \tag{93}$$

$$\bar{Y}_{W(B)} = \left(\frac{\bar{Y}_{B(W)A} \cdot P_{ZW(B)A} + \bar{Y}_{W(B)F} \cdot P_{ZW(B)F}}{P_{ZW(B)}} \right) \tag{94}$$

$\bar{Y}_{W(B)A}$ and $\bar{Y}_{W(B)F}$ are obtained from equations 49 and 54

$$\bar{Y}_H = \bar{Y}_{HA} \tag{95}$$

where $\bar{Y}_{HA}$ is from equation 48

$$\dot{Q} = 0$$

$$\dot{R} = 0$$

$$N_Y = 0$$

NOTE For conditions where the wing flaps are not extended, $\delta_F = 0$, the lift due to wing flap deflection is zero. Therefore, the flap deflection effects in equations 66, 68, 69, 74, 75, 76, 84, 87, 88, 91, 92, 93, and 94 are all zero.

PITCHING ACCELERATION CONDITION

The pitching acceleration condition is an arbitrary condition where a specified value of pitching acceleration is caused by an incremental horizontal tail load and is superimposed on a balanced maneuver condition such that the resulting normal load factor is one-half the design limit positive maneuver load factor.

The incremental horizontal tail load required to produce the specified pitching acceleration, $\dot{Q}$, is:

$$\Delta P_{ZH} = -12 \left(\frac{\dot{Q}\, I_Y}{\bar{X}_H - X_{CG}} \right) \tag{96}$$

where

I_Y = Airplane pitching moment of inertia, slug ft^2

$\bar{X}_H$ is determined by equation 83

The initially estimated component loads for the balanced maneuver part are determined in a manner similar to equations 67 through 84 except that the wing flap deflection effects are zero.

$$\frac{N_{ZL}}{2} = N_{ZM} + \frac{\Delta P_{ZH}}{W} \tag{97}$$

$$N_{ZM} = \frac{N_{ZL}}{2} - \frac{\Delta P_{ZH}}{W} \tag{98}$$

$$C_{LWO} = \frac{1.1\ N_{ZM}\ W}{q\ S_W} \tag{99}$$

$$\alpha_0 = C_{LWO}/C_{L\alpha W} \tag{100}$$

$$P_{ZNO} = 0.043633\ \alpha_0\ R_N^2\ q \tag{101}$$

$$P_{ZW(B)0} = (USZA(SOB))\ C_{LWO}\ q\ S_W \tag{102}$$

$$P_{ZB(W)0} = (USZAB(W))\ C_{LWO}\ q\ S_W \tag{103}$$

$$P_{ZHO} = \Big[(X_{CG} - \bar{X}_N)\ P_{ZNO} + (X_{CG} - \bar{X}_{W(B)A})\ P_{ZW(B)O} + (X_{CG} - \bar{X}_{B(W)A})\ P_{ZB(W)O}\Big] \div [\bar{X}_H - X_{CG}] \tag{104}$$

where $\bar{X}_N$, $\bar{X}_{W(B)A}$, $\bar{X}_{B(W)A}$ and $\bar{X}_H$ are determined using equation 78, 79, 81, and 83, respectively.

$$P_{ZAO} = [P_{ZNO} + P_{ZW(B)O} + P_{ZB(W)O} + P_{ZHO}] \tag{105}$$

The final component airloads for the pitching acceleration condition are determined as follows:

Let

$$K_Z = \frac{N_{ZM} W}{P_{ZAO}} \tag{106}$$

then,

$$P_{ZW(B)} = K_Z \cdot P_{ZW(B)O} \tag{107}$$

$$P_{ZB(W)} = K_Z \cdot P_{ZB(W)O} \tag{108}$$

$$P_{ZH} = K_Z \cdot P_{ZHO} + \Delta P_{ZH} \tag{109}$$

$$P_{ZN} = K_Z \cdot P_{ZNO} \tag{110}$$

$$\bar{X}_{W(B)} = \bar{X}_{W(B)A} \tag{111}$$

$$\bar{X}_{B(W)} = \bar{X}_{B(W)A} \tag{112}$$

$$\bar{Y}_{W(B)} = \bar{Y}_{W(B)A} \tag{113}$$

$$\bar{Y}_H = \bar{Y}_{HA} \tag{114}$$

$$N_Y = 0$$

$$\kappa = 0$$

VERTICAL GUST CONDITION

The vertical gust condition consists of a ±50 fps vertical gust encounter superimposed on a 1.0 g trim condition.

The incremental component airload due to a vertical gust of 50 fps is determined as follows:

$$V_E = (295\ q)^{1/2} \quad \text{KEAS} \tag{115}$$

the airplane mass ratio is,

$$\mu = \frac{2\ (W/S_W)}{\rho\, g\ C_{AV}\ C_{L\alpha W}} \tag{116}$$

$$= \frac{W\ b_W}{16.1\ \rho\ S_W^2\ C_{L\alpha W}} \tag{117}$$

and the alleviation factor is,

when $M < 1.0$:

$$K_g = \frac{0.88\,\mu}{5.3 + \mu} \tag{118}$$

when $M > 1.0$:

$$K_g = \frac{\mu^{1.03}}{6.95 + \mu^{1.03}} \tag{119}$$

the incremental angle of attack due to gust is assumed to act on the aircraft and is,

$$\Delta\alpha_g = U_{DE}/V_E = 50/(1.68894\ V_E) \tag{120}$$

$$= 29.604367/V_E \tag{121}$$

The body nose incremental airload is determined using equation 72 and is

$$\Delta P_{ZN} = 0.043633 \Delta\alpha g R_N^2 q \tag{122}$$

$$= 0.0043788 R_N^2 V_E \tag{123}$$

$$= \frac{R_N^2 V_E}{228.37535} \tag{124}$$

The exposed wing incremental airload is

$$\Delta P_{ZW(B)} = \Delta\alpha g \; Kg \; (C_{L\alpha W})(USZA(SOB)) \; q \; S_W \tag{125}$$

$$= 0.100354 \; Kg \; (C_{L\alpha W})(USZA(SOB) \; S_W \; V_E \tag{126}$$

The wing carry-over incremental airload on the body is

$$\Delta P_{ZB(W)} = 0.100354 \; Kg \; (C_{L\alpha W})(1 - USZA(SOB)) \; S_W \; V_E \tag{127}$$

The incremental airload on the horizontal tail is

$$\Delta P_{ZH} = 0.100354 \; Kg \; (C_{L\alpha H}) \; S_H \; V_E \tag{128}$$

The incremental airplane load factor is,

$$\Delta n_Z = (\Delta P_{ZN} + \Delta P_{ZW(B)} + \Delta P_{ZB(W)} + \Delta P_{ZH}) \div W \tag{129}$$

The airplane pitching acceleration is

$$\dot{Q} = [(X_{CG} - \bar{X}_N)\,\Delta P_{ZN} + (X_{CG} - \bar{X}_{W(B)A})\,\Delta P_{ZW(B)}$$

$$+ (X_{CG} - \bar{X}_{B(W)A})\,\Delta P_{ZB(W)} + (X_{CG} - \bar{X}_H)\,\Delta P_{ZH}] + 12\, I_Y \qquad (130)$$

where $\bar{X}$ values are from equations 78, 79, 81, and 83.

The component airloads for the 1.0 g trim condition are determined using equations 66 through 95, where N_Z = 1.0 and the flap effects are zero.

Component airloads for the gust conditions are then equal to the airloads for the 1.0 g trim condition plus or minus the incremental gust airload, i.e.:

$$P_Z = P_{Z(N_Z=1.0)} \pm \Delta P_{Z(GUST)} \qquad (131)$$

for positive vertical gust use $+\Delta P_Z$ and $+\Delta N_Z$

for negative vertical gust use $-\Delta P_Z$ and $-\Delta N_Z$

$$P_{ZN} = P_{ZN(N=1.0)} \pm \Delta P_{ZN} \qquad (132)$$

$$P_{ZW(B)} = P_{ZW(B)(N=1.0)} \pm \Delta P_{ZW(B)} \qquad (133)$$

$$P_{ZB(W)} = P_{ZB(W)(N=1.0)} \pm \Delta P_{ZB(W)} \qquad (134)$$

$$P_{ZH} = P_{ZH(N=1.0)} \pm \Delta P_{ZH} \qquad (135)$$

$$N_Z = 1.0 \pm \Delta N_Z \qquad (136)$$

$$N_Y = 0$$

$$\dot{R} = 0$$

LATERAL GUST CONDITION

The lateral gust condition consists of a 50 fps lateral gust encounter superimposed on a 1.0 g trim condition.

The lateral gust encounter is assumed to produce a side load on the body nose and on the gross vertical tail area. These loads are determined as follows. The sideslip angle due to lateral gust, βg, is assumed to act on the aircraft is determined using equation 121

$$\beta g = 29.604367/V_E \tag{137}$$

The side load on the nose is determined using equation 123 as follows:

$$P_{YN} = 0.0043788\ R_N^2\ V_E \tag{138}$$

The side load on the vertical tail is determined using equation 128 with $Kg = 1.0$, i.e.:

$$P_{YVT} = 0.100354 \left(C_{Y_{\beta V}}\right) S_V\ V_E \tag{139}$$

where $Cy_{\beta V}$ is determined using equation 19 for subsonic speeds and equation 23 for supersonic speeds.

The center of pressure of the vertical tail side load is as follows:

$\bar{Z}_{VT}$ is obtained from equation 64.

$\bar{X}_{VT} = X_{VE} + \Delta\bar{X}_{VT}$ where $\Delta\bar{X}_{VT}$ is from equation 65.

The airplane yawing acceleration, $\dot{R}$, is determined as follows:

$$\dot{R} = [(X_{CG} - \bar{X}_N)\ P_{YN} + (X_{CG} - \bar{X}_{VT})\ P_{YVT}] + 12\ I_Z \tag{140}$$

The normal loads on wing, body and horizontal tail, $P_{ZW(B)}$, $P_{ZB(W)}$, P_{ZN} and P_{ZH} and their centers of pressure are determined using equations 66 through 95 where

$$N_Z = 1.0 \text{ and } \delta_F = 0$$

and

$$N_Y = (P_{YN} + P_{YVT})/W \tag{141}$$

$$\dot{Q} = 0$$

YAWING ACCELERATION CONDITION

The yawing acceleration condition is an arbitrary condition where a specified value of yawing acceleration is caused by a vertical tail load and is superimposed on a 1.0 g trim condition.

The vertical tail load required to produce the specified yawing acceleration, $\dot{R}$, is

$$P_{YVT} = -12\left(\frac{\dot{R}\ I_Z}{\overline{X}_{VT} - X_{CG}}\right) \tag{142}$$

where

I_Z = airplane yawing moment of inertia, slug ft^2

$\overline{X}_{VT}$ = $X_{VE} + \Delta\overline{X}_{VT}$ where $\Delta\overline{X}_{VT}$ is from equation 65

The normal loads on the wing, body, and horizontal tail and their centers of pressure are determined using equations 66 through 95 where $N_Z = 1.0$ and $\delta_F = 0$ and

$$N_Y = P_{YVT}/W \tag{143}$$

$$\dot{Q} = 0$$

DETERMINATION OF LIFTING SURFACE LIMIT AIRLOAD SHEARS AND MOMENTS

The following methods are employed in the determination of limit airload shears and moments along the span of the lifting surfaces for the specific flight conditions.

The surface unit shears and moments have been determined such that the total panel load (including carry-over load on the body) is equal to unity. Therefore, the unit shears can be multiplied by the total limit panel airload to obtain the limit airload shears and moments as shown in equations 6 through 11.

WING LIMIT AIRLOAD SHEARS AND MOMENTS

The total panel limit airload due to angle of attack is

$$P_{ZA} = (P_{ZW(B)A} + P_{ZB(W)A}) + 2 \qquad (144)$$

and the total panel airload due to flap deflection is

$$P_{ZF} = (P_{ZW(B)F} + P_{ZB(W)F}) + 2 \qquad (145)$$

Then at the selection span stations for weight analysis

$$Y_{\Lambda} = \eta\ (b_W/2)/\cos\Lambda_R = Y/\cos\Lambda_R \qquad (146)$$

$$S_Z = P_{ZA}\ (USZA) + P_{ZF}\ (USZF) \qquad (147)$$

$$M_{X\Lambda} = P_{ZA}\ (UMXA) + P_{ZF}\ (UMXF) \qquad (148)$$

$$M_{Y\Lambda} = P_{ZA}\ (UMYA) + P_{ZF}\ (UMYF) \qquad (149)$$

The shear and moments at the side of the body station Y_{BI} are

$$S_{Z(SOB)} = P_{ZA}\ (USZA(SOB)) + P_{ZF}\ (USZF(SOB)) \tag{150}$$

$$M_{X(SOB)} = P_{ZA}\ (UMXA(SOB)) + P_{ZF}\ (UMXF(SOB)) \tag{151}$$

$$M_{Y(SOB)} = P_{ZA}\ (UMYA(SOB)) + P_{ZF}\ (UMYF(SOB)) \tag{152}$$

HORIZONTAL TAIL (OR CANARD) LIMIT AIRLOAD SHEARS AND MOMENTS

The total panel airload is,

$$P_Z = 1.15\ (P_{ZH}/2) \tag{153}$$

then, at the selected stations for weight analysis,

$$Y_\Lambda = \eta\ (b_H/2)/\cos\Lambda_R = Y/\cos\Lambda_R \tag{154}$$

$$S_Z = P_Z\ (USZA) \tag{155}$$

$$M_{X\Lambda} = P_Z\ (UMXA) \tag{156}$$

$$M_{Y\Lambda} = P_Z\ (UMYA) \tag{157}$$

$$S_{Z(SOB)} = P_Z\ (USZA(SOB)) \tag{158}$$

$$M_{X(SOB)} = P_Z\ (UMXA(SOB)) \tag{159}$$

$$M_{Y(SOB)} = P_Z\ (UMYA(SOB)) \tag{160}$$

VERTICAL TAIL LIMIT AIRLOAD SHEARS AND MOMENTS

Conventional Vertical Tail

The conventional vertical tail is a vertical tail where the horizontal tail is mounted at or below the exposed vertical root and can be single or dual surfaces.

The total panel airload is

$$P_Y = K_V \, P_{YVT} \tag{161}$$

where

K_V = 1.0 for a single vertical tail configuration

and

K_V = 0.55 for a dual vertical tail configuration. (This assumes a 55 to 45 percent load division between the left- and right-hand surfaces.)

Then at selected stations for weight analysis,

$$Z_\Lambda = \eta \, (b_V)/\cos \Lambda_R = Z_V/\cos \Lambda_R \tag{162}$$

$$S_Y = P_Y \, (USYV) \tag{163}$$

$$M_{X\Lambda} = P_Y \, (UMXV) \tag{164}$$

$$M_{Z\Lambda} = P_Y \, (UMZV) \tag{165}$$

$$M_{X(SOB)} = P_Y \, (UMXV(SOB)) \tag{166}$$

$$M_{Z(SOB)} = P_Y \, (UMZV(SOB)) \tag{167}$$

T-Type Vertical Tail

With this type of a vertical tail, an incremental rolling moment from the horizontal tail is introduced at vertical station of the vertical tail/horizontal tail interface in a direction which will add to the vertical tail bending moment. The rolling moment is obtained in accordance with paragraph 3.17 of reference 12 and is equal to 30 percent of the horizontal tail panel (one side) rolling moment, i.e.:

$$\Delta M_{XH} = \left| 0.3 \frac{P_{ZH}}{2} \bar{Y}_H \right| \tag{168}$$

where $M_{X(SOB)}$ is obtained from equation 159.

The incremental bending moment and torsion along the vertical tail load reference line introduced by this incremental rolling moment are then

$$\Delta M_{X\Lambda} = \Delta M_{XH} \cos \Lambda_R \tag{169}$$

$$\Delta M_{Z\Lambda} = \Delta M_{XH} \sin \Lambda_R \tag{170}$$

Let Z_{VH} be the vertical distance from the vertical tail root to the horizontal tail root and

$$\eta_{VH} = Z_{VH}/b_V \tag{171}$$

Then at the stations selected for weight analysis

$$Z_\Lambda = \eta (b_V)/\cos \Lambda_R \tag{172}$$

and when $\eta > \eta_{VH}$

$$P_Y = P_{YVT} \tag{173}$$

$$S_Y = P_Y \text{ (USYV)} \tag{174}$$

$$M_{X\Lambda} = P_Y \text{ (UMXV)} \tag{175}$$

$$M_{Z\Lambda} = P_Y \text{ (UMZV)} \tag{176}$$

and when $\eta > \eta_{VH}$

$$P_Y = P_{YVT} \tag{177}$$

$$S_Y = P_Y \text{ (USYV)} \tag{178}$$

$$M_{X\Lambda} = P_Y \text{ (UMXV)} + \Delta M_{X\Lambda} \tag{179}$$

$$M_{Z\Lambda} = P_Y \text{ (UMZV)} + \Delta M_{Z\Lambda} \tag{180}$$

$$M_{X(SOB)} = P_Y \text{ (UMXV(SOB))} + \Delta M_{X\Lambda} \tag{181}$$

$$M_{Z(SOB)} = P_Y \text{ (UMZV(SOB))} \tag{182}$$

DETERMINATION OF LIFTING SURFACE DESIGN LOADS

The wing and empennage weight estimating module is structured to combine airloads with inertia effects to obtain net surface loads. However, the module is limited to the evaluation of airloads at one specific design temperature, one surface dead weight distribution, and one positive and one negative load factor condition. This approach is not consistent with the capabilities of the airloads module which investigates conditions for which the foregoing design parameters may have multiple values along the structural span. Furthermore, since inertia forces do not always act in opposition to the lifting forces, errors may be introduced in the net loads calculations. Consistency between the airloads module and the weight estimating module is maintained by deriving normalizing factors defining the loads envelope to a given reference base.

Subroutine MAXLDS examines airloads from each of the load conditions to determine the net design positive and negative shear and bending moment conditions. Subroutine WHVNET calculates the normalizing factors and organizes the data for storage in the program file records. Normalizing factors are formulated by using the following reference base.

1. Reference temperature (To) - structure temperature at the condition which results in design net positive bending moment at the root weight analysis station

2. Reference positive load factor (POSNZ) - maximum positive vehicle maneuver load factor

3. Reference negative load factor (XNEGNZ) - maximum negative vehicle maneuver load factor

4. Reference vehicle weight (DGW) - vehicle weight and associated mass distribution at the basic flight design weight (BFDW) with wings in the forward position on variable sweep wing air vehicles.

Material allowables vary with structure temperature such that maximum net loads are not necessarily the design loads. The ratio of material compression yield strength at room temperature (F_{CY80}) to compression yield strength (F_{CY}) at the design condition is applied to the calculated loads. Loads scaled in this manner are then on a common base which provides a rational means for determining the design loads envelope. Furthermore, in order to minimize inaccuracies due to normalizing loads for temperature effects, the reference temperature selection is predicated on the condition which results in design net positive bending moment at the root weight analysis station. This selection minimizes the effect of the temperature normalizing scalar (RS) on the net design bending moment which is the most significant strength sizing (weight) parameter on lifting surfaces.

NET LOADS

Surface net loads are calculated for each of the structural components at each of the load conditions. These calculations differ slightly for each of the lifting surfaces.

Wing Net Loads

Wing and content distributed weight effects are provided to this module through the mass storage files. These effects are in terms of inertia shear and bending moment per unit positive load factor. Net shear and bending moment at the selected span stations for weight analysis are calculated by combining the airload and inertia effects in equations 183 and 184.

$$S_{Z(NET)} = S_Z - N_Z \, [US_{Z(W)} + US_{Z(C)}] \tag{183}$$

$$M_{X\Lambda(NET)} = M_{X\Lambda} - N_Z \left[UM_{X\Lambda(W)} + UM_{X\Lambda(C)}\right] \qquad (184)$$

where

S_Z = shear due to airload

N_Z = vehicle vertical load factor

$US_{Z(W)}$ = shear per unit load factor due to wing weight

$US_{Z(C)}$ = shear per unit load factor due to wing contents

$M_{X\Lambda}$ = swept bending moment due to airload

$UM_{X\Lambda(W)}$ = swept bending moment per unit load factor due to wing weight

$UM_{X\Lambda(C)}$ = swept bending moment per unit load factor due to wing contents

Since structure temperature is a variable, the material compression strength ratio is applied to the calculated net loads to obtain a common base for the selection of design loads.

$$S_{Z(NET)} \left(\frac{F_{CY80}}{F_{CY}}\right) \qquad (185)$$

$$M_{X\Lambda(NET)} \left(\frac{F_{CY80}}{F_{CY}}\right) \qquad (186)$$

Conditions which produce maximum net positive and negative shear and bending moment are made from comparative tests of equations 185 and 186. The shear and moment equations can then be normalized to a common reference temperature.

$$S_Z' = S_{Z(NET)} \left(\frac{F_{CY80}}{F_{CY}}\right) \left(\frac{F_{CYR}}{F_{CY80}}\right) = S_{Z(NET)}\, RS_S \qquad (187)$$

$$M'_{X\Lambda} = M_{X\Lambda(NET)} \left(\frac{F_{CY80}}{F_{CY}}\right)\left(\frac{F_{CYR}}{F_{CY80}}\right) = M_{X\Lambda(NET)}\ RS_M \tag{188}$$

where

F_{CYR} = material compression yield stress at the reference temperature

In order to provide the loads data in a form acceptable to the weight estimating module, additional factors are determined to account for load factor and content inertia effect variations. The normalized shear and bending moment take the form shown in equations 189 and 190.

$$S'_Z = \left\{ S_Z - RNZ_S\ N_{ZR}\ (US_{Z(W)} + RC_S\ US_{Z(CR)}) \right\} RS_S \tag{189}$$

$$M'_{X\Lambda} = \left\{ M_{X\Lambda} - RNZ_M\ N_{ZR}\ (UM_{X\Lambda(W)} + RC_M\ UM_{X\Lambda(CR)}) \right\} RS_M \tag{190}$$

where

N_{ZR} = POSNZ when S'_Z is positive in equation 189

= XNEGNZ when S'_Z is negative in equation 189

RNZ_S = N_Z/N_{ZR}, load factor ratio at design shear

$US_{Z(CR)}$ = shear per unit load factor due to wing contents at the reference vehicle weight

RC_S = $US_{Z(C)}/US_{Z(CR)}$, content ratio at design shear

RS_S = F_{CYR}/F_{CY}, strength ratio at design shear

N_{ZR} = POSNZ when $M'_{X\Lambda}$ is positive in equation 190

= XNEGNZ when $M'_{X\Lambda}$ is negative in equation 190

RNZ_M = N_Z/N_{ZR}, load factor ratio at design bending

$UM_{X\Lambda(CR)}$ = swept bending moment per unit load factor due to wing contents at the reference vehicle weight

RC_M = $UM_{X\Lambda(C)}/UM_{X\Lambda(CR)}$, content ratio at design bending

RS_M = F_{CYR}/F_{CY}, strength ratio at design bending

The foregoing approach accounts for the evaluation of all flight conditions. Net wing shear and bending moment for the taxi condition is also examined to determine whether taxi design loads are critical. Should taxi be critical, the net shear and moment are substituted as hypothetical airloads with the corresponding load factor ratios (RNZ_S and RNZ_M) set to 0.0.

Horizontal Tail Net Loads

Horizontal tail net design loads are calculated from equations 183 and 184. Since the tail is offset from the vehicle center of gravity, the local acceleration is used in the net loads equations. The local vertical acceleration at the tail is calculated by equation 191.

$$N_{ZHT} = N_Z - \frac{\dot{Q}\ (XCG_{HT} - X_{CG})}{12\ g} \tag{191}$$

where

N_Z = vehicle vertical load factor

$\dot{Q}$ = pitching acceleration, radians/sec^2

XCG_{HT} = CG of the horizontal tail and contents which is estimated by adding two-thirds of the root chord to the apex station of the horizontal tail, in.

XCG = vehicle CG, in.

g = acceleration of gravity, ft/sec^2

Horizontal tail contents do not vary with the different design conditions and, therefore, the content ratios RC_S and RC_M are always equal to 1.0.

Horizontal tail airloads are reversed when the net negative bending moment at the root weight analysis station is greater than the net positive bending moment. (The weight estimating module assumes that the positive loads are larger than the negative loads.) When the loads are reversed, an indicator is placed in XMISC(42). When this indicator is not 0, the reference positive and negative load factors are reversed in the weight estimating module calculations.

Vertical Tail Net Loads

Inertia and airloads that affect the vertical tail act in the lateral direction. The local acceleration at the tail is calculated by equation 192.

$$N_{YVT} = N_Y - \frac{\dot{R}\,(XCG_{VT} - X_{CG})}{12\ g} \tag{192}$$

where

N_Y = vehicle lateral load factor

$\dot{R}$ = yawing acceleration, radians/sec^2

XCG_{VT} = CG of the vertical tail and contents which is estimated by adding two-thirds of the root chord to the apex station of the vertical tail, in.

XCG = vehicle CG, in.

The net design shear and moment calculations take the form shown in equations 193 and 194 which are similar to the wing net load equations

$$S'_Y = \left\{ S_Y - RNZ_S\, N_{ZR}\, (US_{Y(V)} + RC_S\, US_{Y(C)}) \right\} RS_S \tag{193}$$

$$M'_{X\Lambda} = \left\{ M_{X\Lambda} - RNZ_M\, N_{ZR}\, (UM_{X\Lambda(V)} + RC_M\, UM_{X\Lambda(C)}) \right\} RS_M \tag{194}$$

where

N_{ZR} = POSNZ for all conditions

RNZS = N_{YVT}/N_{ZR}, load factor ratio at design shear

RNZ_M = N_{YVT}/N_{ZR}, load factor ratio at design bending

Vertical tail contents RC_S and RC_M are always equal to 1.0 since contents do not vary with the different design conditions.

DETERMINATION OF WING BENDING MOMENT SPECTRA

A simplified approach is used to estimate the wing bending moment spectra at two stations on the wing. It is assumed that the total wing airload per side (including the carry-over load on the body) is equal to one-half the product of the load factor, n, times the airplane weight, W. Then, for a given flight segment where the mach number, altitude, and weight are constant, the wing load and the bending moment are proportional to the load factor. A gust and a maneuver bending moment spectrum are developed for each flight segment based on the gust and the maneuver load factor spectra.

BLOCKED USAGE FLIGHT SEGMENTS

The blocked usage segments represent the operational flight usage of the aircraft for the specified service life. Each segment represents time spent under a type of operation at a fixed mach number, altitude, wing sweep position, and airplane weight. Eight flight segments for each class of airplane have been selected to represent the service life usage.

Typical blocked usage segments have been estimated for the fighter, attack, bomber-BI, bomber-BII, cargo-assault, and cargo-transport airplane classes. These data are presented in Tables 5 through 10, and are contained in the SWEEP computer program data bank. It should be noted that these blocked usage segments are strictly an estimate, and it is suggested that the user replace these data if more realistic data are available for a specific airplane. In Tables 5 through 10, W_o is the average takeoff weight and T_L is the specified service life in flight hours.

TABLE 5. TYPICAL BLOCKED USAGE SEGMENTS FOR FIGHTER CLASS

Blocked Usage Segment	Avg Mach No.	Avg Altitude (ft)	Wing Sweep Position	Weight Fraction W/W_o	Life Fraction T/T_L
Ascent	0.70	15,000	Fixed	1.00	0.07
Cruise	0.70	20,000	Fixed	0.95	0.15
Cruise	2.00	40,000	Fixed	0.80	0.10
Cruise	0.90	25,000	Fixed	0.80	0.20
Cruise	0.85	0	Fixed	0.80	0.15
Air-ground	0.80	0	Fixed	0.80	0.10
Air-Air	0.80	10,000	Fixed	0.75	0.05
Loiter/ Descent	0.60	10,000	Fixed	0.70	0.18

TABLE 6. TYPICAL BLOCKED USAGE SEGMENTS FOR ATTACK CLASS

Blocked Usage Segment	Avg Mach No.	Avg Altitude (ft)	Wing Sweep Position	Weight Fraction W/W_0	Life Fraction T/T_L
Ascent	0.70	15,000	Fixed	1.00	0.08
Cruise	0.70	10,000	Fixed	0.95	0.25
Cruise	0.85	40,000	Fixed	0.80	0.20
Cruise	0.80	0	Fixed	0.80	0.12
Air-air	0.95	10,000	Fixed	0.75	0.05
Air-Ground	0.80	0	Fixed	0.80	0.12
Descent	0.60	15,000	Fixed	0.70	0.08
Loiter	0.60	10,000	Fixed	0.70	0.10

TABLE 7. TYPICAL BLOCKED USAGE SEGMENTS FOR BI CLASS

Blocked Usage Segment	Avg Mach No.	Avg Altitude (ft)	Wing Sweep Position	Weight Fraction W/W_0	Life Fraction T/T_L
Ascent	0.70	15,000	Fixed	1.00	0.08
Cruise	0.70	10,000	Fixed	0.95	0.20
Cruise	0.85	40,000	Fixed	0.80	0.25
Cruise	0.70	0	Fixed	0.80	0.12
Cruise	0.75	5,000	Fixed	0.75	0.05
Cruise	0.60	0	Fixed	0.80	0.12
Descent	0.60	15,000	Fixed	0.70	0.08
Loiter	0.60	10,000	Fixed	0.70	0.10

TABLE 8. TYPICAL BLOCKED USAGE SEGMENTS FOR BII CLASS

Blocked Usage Segment	Avg Mach No.	Avg Altitude (ft)	Wing Sweep Position	Weight Fraction W/W_0	Life Fraction T/T_L
Ascent	0.355	0	Fixed	1.0	0.104
Cruise	0.70	30,000	Fixed	0.8611	0.0654
Cruise	0.70	30,000	Fixed	0.8611	0.6199
Refuel	0.70	25,000	Fixed	1.0833	0.0407
Cruise	2.20	50,000	Fixed	0.6944	0.0269
Penetrate	0.85	0	Fixed	0.8611	0.1081
Penetrate	0.95	0	Fixed	0.6944	0.0232
Penetrate	0.55	0	Fixed	0.75	0.0118

TABLE 9. TYPICAL BLOCKED USAGE SEGMENTS FOR CARGO ASSAULT CLASS

Blocked Usage Segment	Avg Mach No.	Avg Altitude (ft)	Wing Sweep Position	Weight Fraction W/W_o	Life Fraction T/T_L
Ascent/ Descent	0.60	20,000	Fixed	0.94	0.2185
Ascent	0.60	20,000	Fixed	1.10	0.0044
Ascent/ Descent	0.40	5,000	Fixed	0.94	0.0332
Cruise	0.75	40,000	Fixed	0.94	0.3341
Cruise	0.75	40,000	Fixed	1.06	0.0255
Cruise	0.65	20,000	Fixed	0.94	0.0354
Cruise	0.47	10,000	Fixed	0.91	0.0135
Cruise	0.456	1,000	Fixed	0.91	0.3354

TABLE 10. TYPICAL BLOCKED USAGE SEGMENTS FOR CARGO TRANSPORT CLASS

Blocked Usage Segment	Avg Mach No.	Avg Altitude (ft)	Wing Sweep Position	Weight Fraction W/W_o	Life Fraction T/T_L
Ascent	0.50	20,000	Fixed	1.00	0.05
Ascent/ Descent	0.50	10,000	Fixed	0.70	0.05
Cruise	0.80	30,000	Fixed	0.80	0.25
Cruise	0.85	40,000	Fixed	0.75	0.30
Cruise	0.75	25,000	Fixed	0.80	0.15
Cruise	0.70	15,000	Fixed	0.70	0.10
Cruise	0.65	10,000	Fixed	0.70	0.05
Cruise	0.55	1,000	Fixed	0.70	0.05

MANEUVER LOAD FACTOR SPECTRA

Maneuver load factor spectra for each airplane class are presented in Tables 11 through 15. The number of exceedances of given load factor levels per 1,000 flight hours are shown for each type usage segment. These data are based on the load factor spectra of references 13 or 14.

The spectra for the fighter and attack classes (Table 11) correspond to Table III of reference 13, except that the ascent cruise, descent, and loiter spectra have been consolidated into one representative spectrum and a representative supersonic air-to-air combat spectrum has been added.

TABLE 11. MANEUVER LOAD FACTOR SPECTRA FOR FIGHTER OR ATTACK CLASSES

Load Factor (n_z)	Exceedances per 1,000 Hours by Mission Segment			
	Ascent Cruise, Loiter, or Descent	Air-to-Ground Combat	Subsonic Air-to-Air Combat	Supersonic Air-to-Air Combat
10.0	0	0	15	0
9.0	0	1	60	0
8.0	0	15	230	16
7.0	0.04	200	900	90
6.0	1.0	1,500	3,400	500
5.0	25	10,000	13,000	2,900
4.0	400	40,000	50,000	17,000
3.0	3,500	100,000	150,000	90,000
2.0	15,000	175,000	300,000	250,000
1.5	24,000	210,000	390,000	320,000
0.5	0.0	10,000	44,000	16,000
0.0	0.0	350	4,000	2,000
-1.0	0.0	7	350	45
-2.0	0.0	1	8	0.1
-3.0	0.0	0	0.1	0
-4.0	0.0	0	0	0

The spectrum for the bomber-BI class (Table 12) is based on the B spectrum of Table II of reference 14 which is believed to be representative of a consolidation of the spectra of Table V of reference 13. The load factor levels are also changed to increments of 0.5 g.

The spectra for the bomber-BII class (Table 13) correspond to the spectra of Table VI of reference 13, except that the ascent, descent, and refueling spectra have been consolidated into one spectrum and a representative low-altitude penetration spectrum has been added. The load factor levels are also changed to increments of 0.3 g.

The spectra for the cargo-assault class (Table 14) correspond to the spectra of Table VIII of reference 13, except the ascent and descent spectra are consolidated into one spectrum and the load factor levels are changed to increments of 0.3 g.

TABLE 12. MANEUVER LOAD FACTOR SPECTRUM FOR BI CLASS, ALL SEGMENTS

Load Factor (n_z)	Exceedances per 1,000 Hours
6.0	0
5.5	0.5
5.0	3
4.5	18
4.0	70
3.5	250
3.0	800
2.5	2,500
2.0	9,200
1.5	31,000
0.5	1,000
0.0	350
-0.5	1
-1.0	0

The spectra for the cargo-transport class (Table 15) correspond to the spectra of Table VII of reference 13, except that the ascent, descent, and refueling spectra have been consolidated into one spectrum. The resulting spectra were obtained with a weighting of 80 percent logistics and 20 percent training, and the load factor levels are also changed to increments of 0.3 g.

The maneuver load factor spectrum for a given blocked usage segment is based on the time spent in the segment and number of load factor exceedances per 1,000 hours.

Let,

N_{EXM} = number of exceedances of a specific maneuver load factor for the blocked usage segment

N_{EX} = number of exceedances of a specific maneuver load factor per 1,000 hours for the type of segment

T_{SEG} = total hours spent in the blocked usage segment

TABLE 13. MANEUVER LOAD FACTOR SPECTRA FOR BII CLASS

Load Factor (n_z)	Exceedances per 1,000 Hours by Segment		
	Ascent, Descent, or Refueling	Cruise or High-Altitude Penetration	Low-Altitude Penetration
3.5	0	0	0
3.2	0.01	0	0.02
2.9	0.06	0.003	0.12
2.6	0.3	0.03	0.6
2.3	2	0.40	4
2.0	15	4	30
1.7	300	60	600
1.4	7,200	1,300	14,400
1.1	150,000	35,000	300,000
0.9	85,000	20,000	300,000
0.6	3,900	240	14,400
0.3	86	4	600
0.0	7	0.1	30
-0.3	0.9	0.002	4
-0.6	0.1	0	0.6
-0.9	0.01	0	0.12
-1.2	0	0	0.02
-1.5	0	0	0

then

$$T_{SEG} = T_L (T/T_L)_{SEG} \tag{195}$$

$$N_{EXM} = \left(\frac{T_{SEG}}{1000}\right) N_{EX} \tag{196}$$

TABLE 14. MANEUVER LOAD FACTOR SPECTRA FOR CARGO ASSAULT CLASS

Load Factor (n_z)	Exceedances per 1,000 Hours by Segment	
	Ascent or Descent	Cruise
3.8	0	0
3.5	0.05	0.02
3.2	0.12	0.05
2.9	0.25	0.11
2.6	0.50	0.25
2.3	1.8	0.54
2.0	10	2
1.7	130	16
1.4	1,500	300
1.1	100,000	10,000
0.9	30,000	5,000
0.6	100	30
0.3	0.5	1
0.0	0.002	0.03
-0.3	0	0.001
-0.6	0	0

TABLE 15. MANEUVER LOAD FACTOR SPECTRA FOR CARGO TRANSPORT CLASS

Load Factor (n_z)	Exceedances per 1,000 Hours by Segment	
	Ascent, Descent or Refueling	Cruise
3.5	0	0
3.2	0.03	0
2.9	0.17	0
2.6	0.90	0.003
2.3	4	0.05
2.0	19	1
1.7	105	25
1.4	1470	825
1.1	70,000	30,000
0.9	8,000	1,920
0.6	136	22
0.3	0.30	0.15
0.0	0.001	0.001
-0.3	0	0

where

T/T_L is obtained from the appropriate Table 5, 6, 7, 8, 9, or 10

N_{EX} is obtained from the appropriate Table, 11, 12, 13, 14, or 15

T_L is the specified airplane service life in hours

GUST LOAD FACTOR SPECTRA

The gust load factor spectra are developed using a simplified continuous turbulence approach based on references 15 and 16. The exceedances of a given load factor, N_{EXG}, for a specific blocked mission segment is determined using the following method:

$$N_{EXG} = 3600\ T_{SEG}\ N_o \left[P_1\ e^{-\Delta n_z/\bar{A}\ b_1} + P_2\ e^{-\Delta n_z/\bar{A}\ b_2} \right] \qquad (197)$$

where,

T_{SEG} is from equation 195

N_o is the average number cycles of load factor per second and is

$$N_o = \frac{7.5\ V_T}{5280} \quad \text{(per reference 15)} \qquad (198)$$

V_T = true airspeed (fps) corresponding to the blocked segment mach number and altitude

Δn_z is the incremental gust load factor and is

$$\Delta n = \left| n_z - 1 \right| \qquad (199)$$

P_1 P_2, b_1 and b_2 are the turbulence field parameters obtained from Table 16 by interpolation at the blocked segment altitude.

$$\bar{A} = K\sigma \left[\frac{\rho V_T C_{L_\alpha}}{2(W/S_W)} \right] \quad \text{(per reference 16)} \tag{200}$$

$K\sigma$ is the gust response factor obtained from Table 17 by interpolation at the appropriate values of $\bar{C}/L$ and μ for the blocked segment weight, speed, and altitude.

$\bar{C}$ is the average wing chord in feet.

L is the scale of turbulence in feet and is obtained from Table 16 for the blocked segment altitude.

μ is the airplane mass-ratio and is obtained using equation 116 for the blocked segment weight, speed, and altitude.

TABLE 16. TURBULENCE FIELD PARAMETERS

Altitude (ft)	P1	B1	P2	B2	L (ft)
0	1.00000	2.70	0.000010	10.65	500
250	1.00000	2.70	0.000010	10.65	500
1,000	1.00000	2.70	0.000010	10.65	500
1,750	0.42000	3.02	0.003300	5.94	1,750
3,750	0.30000	3.42	0.002000	8.17	2,500
7,500	0.15000	3.59	0.000950	9.22	2,500
15,000	0.06200	3.27	0.000280	10.52	2,500
25,000	0.02500	3.15	0.000110	11.88	2,500
35,000	0.01100	2.93	0.000095	9.84	2,500
45,000	0.00460	3.28	0.000115	8.81	2,500
55,000	0.00200	3.82	0.000078	7.04	2,500
65,000	0.00088	2.93	0.000057	4.33	2,500

TABLE 17. GUST RESPONSE FACTORS

	$K\sigma$								
μ	C/L 0.002	C/L 0.004	C/L 0.006	C/L 0.010	C/L 0.015	C/L 0.020	C/L 0.040	C/L 0.060	C/L 0.100
5	0.130	0.180	0.210	0.240	0.270	0.300	0.350	0.390	0.430
10	0.200	0.250	0.290	0.340	0.380	0.415	0.480	0.520	0.550
20	0.270	0.340	0.380	0.440	0.490	0.525	0.590	0.610	0.625
30	0.320	0.400	0.450	0.515	0.565	0.595	0.640	0.660	0.660
40	0.340	0.440	0.500	0.565	0.615	0.643	0.690	0.695	0.680
60	0.410	0.510	0.565	0.632	0.676	0.700	0.735	0.730	0.708
100	0.500	0.600	0.655	0.712	0.745	0.762	0.772	0.760	0.725
140	0.550	0.650	0.710	0.760	0.782	0.790	0.790	0.770	0.735
200	0.620	0.715	0.760	0.800	0.817	0.820	0.805	0.785	0.742
300	0.685	0.770	0.805	0.836	0.845	0.843	0.820	0.790	0.747

TAXI LOAD FACTOR SPECTRA

The taxi load factor spectra are presented in Table 18 for each airplane class and are the same as Table I of reference 13 except that the spectra are converted to exceedances of load factor per 1,000 landings (rather than occurrences of load factor per 1,000 landings).

Two taxi spectra are considered; that is, one at the average takeoff weight and one at the average landing weight and both having the same load factor exceedances.

Let

N_{EXT} = number of exceedances of a specific taxi load factor for the service life for the average takeoff or landing weight

N_{EX} = number of exceedance of a specific taxi load factor per 1,000 landings obtained from Table 18

N_{LDG} = total number of landings specified for the airplane service life

Then, for a specific taxi load factor,

$$N_{EXT} = N_{EX}(N_{LDG}/2000) \qquad (201)$$

TABLE 18. TAXI LOAD FACTOR SPECTRA

Load Factor (n_z)	Exceedances per 1,000 Landings	
	F, A, or BI Class	BII, Cargo-Assault, or Cargo-Transport Class
1.8	0.001	0.002
1.7	0.03	0.06
1.6	0.9	1.8
1.5	20	40
1.4	450	900
1.3	9,000	18,000
1.2	86,000	172,000
1.1	330,000	660,000
0.9	330,000	660,000
0.8	86,000	172,000
0.7	9,000	18,000
0.6	450	900
0.5	20	40
0.4	0.9	1.8
0.3	0.03	0.06
0.2	0.001	0.002

GROUND-AIR-GROUND CYCLE LOAD FACTOR SPECTRUM

The ground-air-ground cycle load factor spectrum is arbitrarily assumed to consist of a total number of constant amplitude cycles, N_{GAG}, equal to the total number of landings, N_{LDG}, specified for the airplane service life. The minimum load level corresponds to a taxi load factor of 1.2 g at the average takeoff weight, and the maximum load level corresponds to a flight load factor of one-half the positive design limit load factor at a weight equal to that of the initial ascent blocked usage segment.

$$N_{GAG} = N_{LDG} \tag{202}$$

WING BENDING MOMENT SPECTRA

Wing bending moment spectra are developed for the specified airplane class for each of the eight blocked usage segments, for taxi at the average takeoff weight and at the average landing weight, and for the ground-air-ground cycles. The net bending moment (airload plus inertia) spectra are determined at two wing stations:

1. The exposed panel rolling moment at the wing-body interface station, Y_{BI}, side of the body

2. The wing bending moment at a specified station, Y, along the load reference line

Blocked Segment Bending Moment Spectra

For each of the eight blocked usage segments of the appropriate Table 5, 6, 7, 8, 9, or 10, the following procedures are used to determine the wing bending moment spectra:

1. Using the blocked mission segment mach number, determine the unit airload bending moments UMXA and UMXA(SOB) using equations 32 and 43, respectively, where $\eta = (2Y_\Lambda/b)\cos\Lambda_R$. Determine the wing lift curve slope, C_{L_α}, using the appropriate equation (19) or (23).

2. For the specified airplane class and blocked segment type, determine the exceedances, N_{EXM}, of each maneuver load factor level listed in the appropriate Table 11, 12, 13, 14, or 15 using equations 195 and 196.

3. Determine the exceedances, N_{EXG}, of gust factor levels for the same load factor levels of item 2 using the blocked segment weight, mach number and altitude, and equation 197.

4. Determine the net bending moments at the two wing stations for each load factor level as follows:

$$M_X(SOB) = \left(\frac{n_z W_S}{2}\right) UMXA(SOB) + n_z\left(\frac{M_X}{n_z}\right)_S \qquad (203)$$

$$M_{X_\Lambda}(Y_\Lambda^{\cdot}) = \left(\frac{n_z W_S}{2}\right) (UMXA) + n_z\left(\frac{M_{X_\Lambda}}{n_z}\right)_S \qquad (204)$$

where

n_z is the load factor for which exceedances have been determined

UMXA(SOB) and UMXA are the unit airload bending moments at wing stations Y_{BI} and Y_Λ, respectively.

(M_X/n_z) and $(M_{X\Lambda}/n_z)_S$ are the unit inertia bending moments at wing stations Y_{BI} and Y_Λ, respectively.

W is the blocked segment weight and is,

$$W = W_o(W/W_o) \tag{205}$$

where

W_o is the specified average takeoff weight

and

W/W_o is blocked segment weight fraction.

5. A sample maneuver and gust wing bending moment spectra for a cargo-assault class airplane is shown in Table 19 for the first blocked usage ascent/descent segment of Table 9. Notes are presented to illustrate how data were obtained.

Taxi Bending Moment Spectra

The wing bending moment spectra for the taxi load factor spectra are obtained as follows:

1. Using Table 18 for the appropriate airplane class, the number of exceedances, N_{EXT}, of each load factor level are obtained by equation 201.

2. This load factor spectra is used to determine the wing bending spectra for the average takeoff weight and the average landing weight. At each load factor level, the wing bending moments are determined using equations 203 and 204 modified as follows.

TABLE 19. SAMPLE BLOCKED USAGE SEGMENT MANEUVER AND GUST WING BENDING MOMENT SPECTRA FOR CARGO ASSAULT CLASS

Load Factor (n_z) (note 1)	Gust ΔN_Z (note 2)	$M_{X(SOB)}$ AT $Y_{BW}=72$ (note 3)	$M_{X\Lambda}$ AT $Y_{\Lambda}=250.4$ (note 4)	Gust Exceedances N_{EXG} (note 5)	Maneuver Exceedances N_{EXM} (note 6)
3.2	2.2	35033490	17081280	0.0	0.5
2.9	1.9	31749100	15749920	0.0	1.1
2.6	1.6	28464700	13878550	0.0	2.2
2.3	1.3	25180320	12277180	0.3	7.9
2.0	1.0	21895940	10675810	2.6	43.7
1.7	1.7	18611540	9074440	19.8	568.2
1.4	0.4	15327150	7473060	191	6654
1.1	0.1	12042760	5871690	51,214	436,996
0.9	-0.1	9853170	4804110	51,214	131,096
0.6	-0.4	6568780	3202740	191	437
0.3	-0.7	3284390	1601370	19.8	1.3
0.0	-1.0	0	0	2.6	0.0
-0.3	-1.3	-3284390	-1601370	0.3	0.0
-0.6	-1.6	-6568780	-3202740	0.0	0.0

NOTES

1. n_z is obtained from Table 14.

2. Δn_z is obtained using equation 199.

3. $M_{X(SOB)}$ is obtained using equation 203.

4. $M_{X\Lambda}$ is obtained using equation 204.

5. N_{EXG} is obtained using equation 197.

6. N_{EXM} is obtained using equation 196 and Table 14.

For the bending moments at takeoff weight,

$$M_{X(SOB)} = n_z\left(\frac{M_X}{n_z}\right)_o \tag{206}$$

$$M_{X_\Lambda (Y_\Lambda)} = n_z\left(\frac{M_{X_\Lambda}}{n_z}\right)_o \tag{207}$$

For the bending moments at landing weight,

$$M_{X(SOB)} = n_z\left(\frac{M_X}{n_z}\right)_{LDG} \tag{208}$$

$$M_{X_\Lambda (Y_\Lambda)} = n_z\left(\frac{M_{X_\Lambda}}{n_z}\right)_{LDG} \tag{209}$$

where

$$\left(\frac{M_X}{n_z}\right)_o \text{ and } \left(\frac{M_{X_\Lambda}}{n_z}\right)_o$$

are the wing unit inertia bending moments at stations Y_{BI} and Y_Λ, respectively, for the average takeoff weight.

$$\left(\frac{M_X}{n_z}\right)_{LDG} \text{ and } \left(\frac{M_{X_\Lambda}}{n_z}\right)_{LDG}$$

are the wing unit inertia bending moments at stations Y_{BI} and Y_Λ, respectively, for the average landing weight.

Ground-Air-Ground Cycle Bending Moments

The wing bending moments for the ground-air-ground cycles are determined using equations 203 and 204 modified as follows:

For the maximum wing bending moments,

$$M_{X(SOB)} = \left(\frac{n_{z_L} W1}{4}\right) UMXA(SOB) + \frac{n_{z_L}}{2}\left(\frac{M_X}{n_z}\right)_1 \qquad (210)$$

$$M_{X_{\Lambda}(Y_{\Lambda})} = \left(\frac{n_{z_L} W_1}{4}\right)(UMXA) + \frac{n_{z_L}}{2}\left(\frac{M_{X_{\Lambda}}}{n_z}\right)_1 \qquad (211)$$

For the minimum wing bending moments,

$$M_{X(SOB)} = 1.2\left(\frac{M_X}{n_z}\right)_o \qquad (212)$$

$$M_{X_{\Lambda}(Y_{\Lambda})} = 1.2\left(\frac{M_{X_{\Lambda}}}{n_z}\right)_o \qquad (213)$$

where

n_{z_L} is the positive design limit maneuver load factor.

W_1 is the airplane weight in the initial ascent segment.

$\left(\frac{M_X}{n_z}\right)_1$ is the unit inertia bending moment wing station Y_{BI} for the initial ascent segment.

$\left(\frac{M_{X_\Lambda}}{n_z}\right)_1$ is the unit inertia bending moment at wing station Y_Λ for the initial ascent segment.

$\left(\frac{M_X}{n_z}\right)_o$ and $\left(\frac{M_{X_\Lambda}}{n_z}\right)_o$ are the unit inertia bending moments at wing stations Y_{BI} and Y_Λ, respectively, for the average takeoff weight.

Section III

PROGRAM DESCRIPTION

GENERAL DESCRIPTION

The airloads module has been developed to determine air vehicle component limit airloads and wing bending moment fatigue spectra. Methods, equations, and logic discussed in the previous section are programmed in FORTRAN IV for the CDC 6600 computer. Limit airloads consist of airload and center of pressure (CP) for each airplane component and airload shear, bending moment, and torsion distributions on wing and empennage surfaces. Fatigue data consist of gust and maneuver spectra for eight flight segments, two taxi segments, and a ground-air-ground segment.

Data input to this module consist of the permanent file aerodynamic data records, and the vehicle-oriented data, generated by the data management module and the flutter and temperature module. The flow of data to this module and the usage of data calculated by this module are shown in Figure 7.

PROGRAM FUNCTIONS

The airloads module main program, BLCNTL, uses four main subroutines, five subordinate subroutines, and two function routines. The main subroutines are USPAN, BNLDS, SPABM, and FATMG.

Subroutine USPAN calculates lifting surface unit airload shears, bending moments, torques, centers of pressure, and lift curve slopes for a specified mach number.

Subroutine BNLDS calculates gross limit airloads and centers of pressure on each of the airplane components and the inertia factors for the specified case condition.

Subroutine SPABM calculates limit airload shear, bending moment, and torsional moment distributions on wing and empennage surfaces for each specific flight condition.

Subroutine FATMG calculates wing bending moment spectra at a wing side of fuselage station and an outboard station.

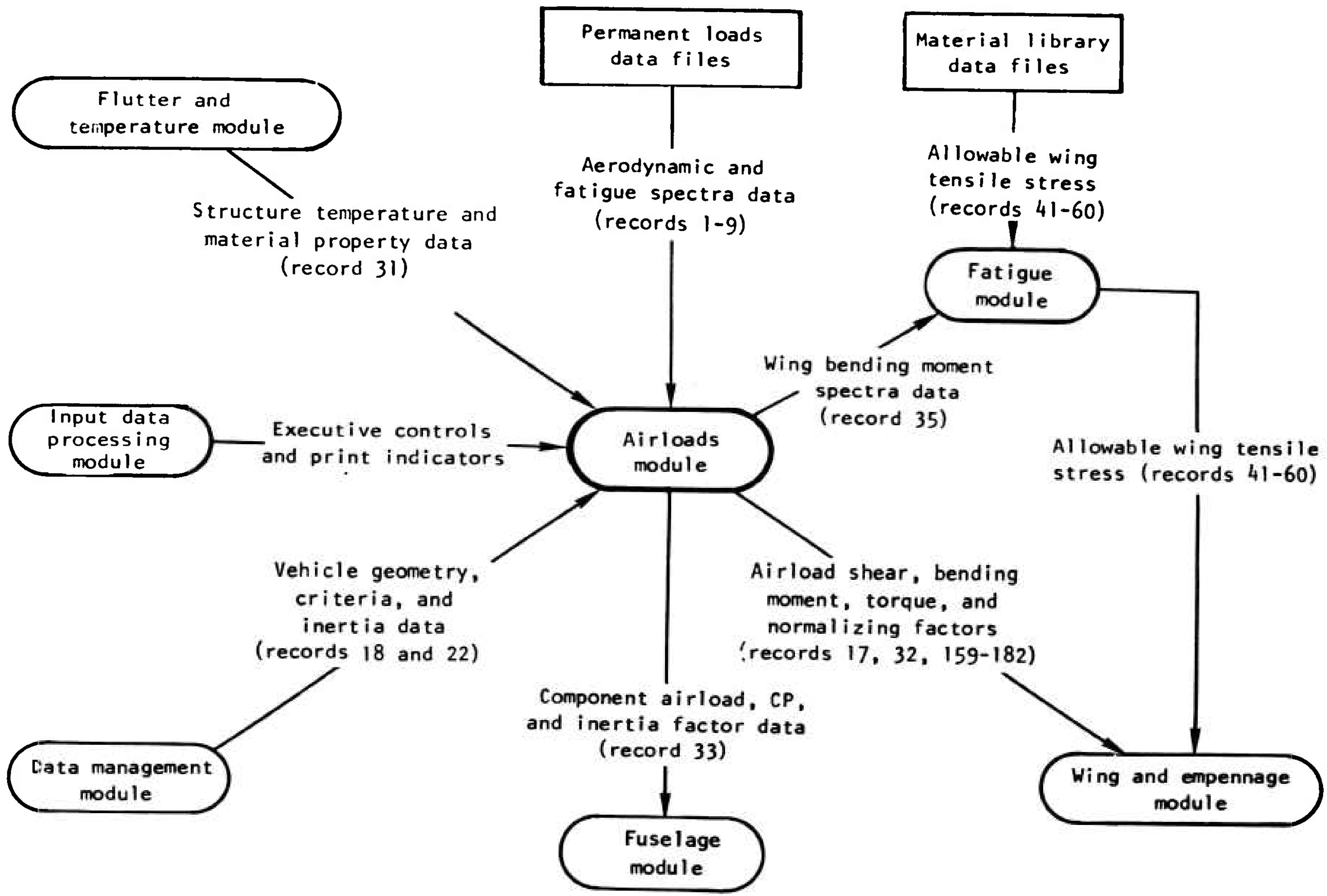


Figure 7. Flow of airload module dependent data.

Subordinate subroutines are used to calculate atmospheric properties and to process the airloads data for use by the fatigue and weight estimating modules. These routines are:

- ATMOS Determines the standard atmosphere density, pressure, and the speed of sound at a given altitude
- MAXLDS Scans the load case data to define the net design loads envelope for the wing and empennage surfaces
- WHVNET Organizes the net design loads envelope data; calculates temperature, load factor, and content inertia normalizing factors; and stores the data for use by the wing and empennage weight estimating modules
- FUSNET Rearranges and stores vehicle loads and inertia factors for use by the fuselage weight estimating module

Purposes of the function routines are as follows:

- CODIM2 Curve fitting interpolation routine for determination of a value on a single curve
- FCODM2 Curve fitting interpolation routine for determination of a value from a family of curves

The calling-called matrix for the program showing interdependence of routines is shown in Figure 8. The logical flow chart of this module is shown in Figure 9. Expanded discussions of each of the routines are included in this section. Methods employed are described in Section II of this volume. Logical flow charts and program listings are shown in Appendix A.

GENERAL MAPS

Data storage and transmittal is accomplished through the use of common, labeled common, and mass storage files. Mass storage file records are read into and written from regions in common or from program regions. Those arrays that are written from records in the program region are:

Calling \ Called	USPAN	BNLDS	SPABM	MAXLDS	FUSNET	WHVNET	FATMG	ATMOS	CODIM2	FCODM2
BLCNTL	X	X	X	X	X	X	X			
USPAN									X	X
BNLDS								X	X	
FATMG	X							X	X	X
FCODM2									X	

Figure 8. Calling-called matrix for airload module.

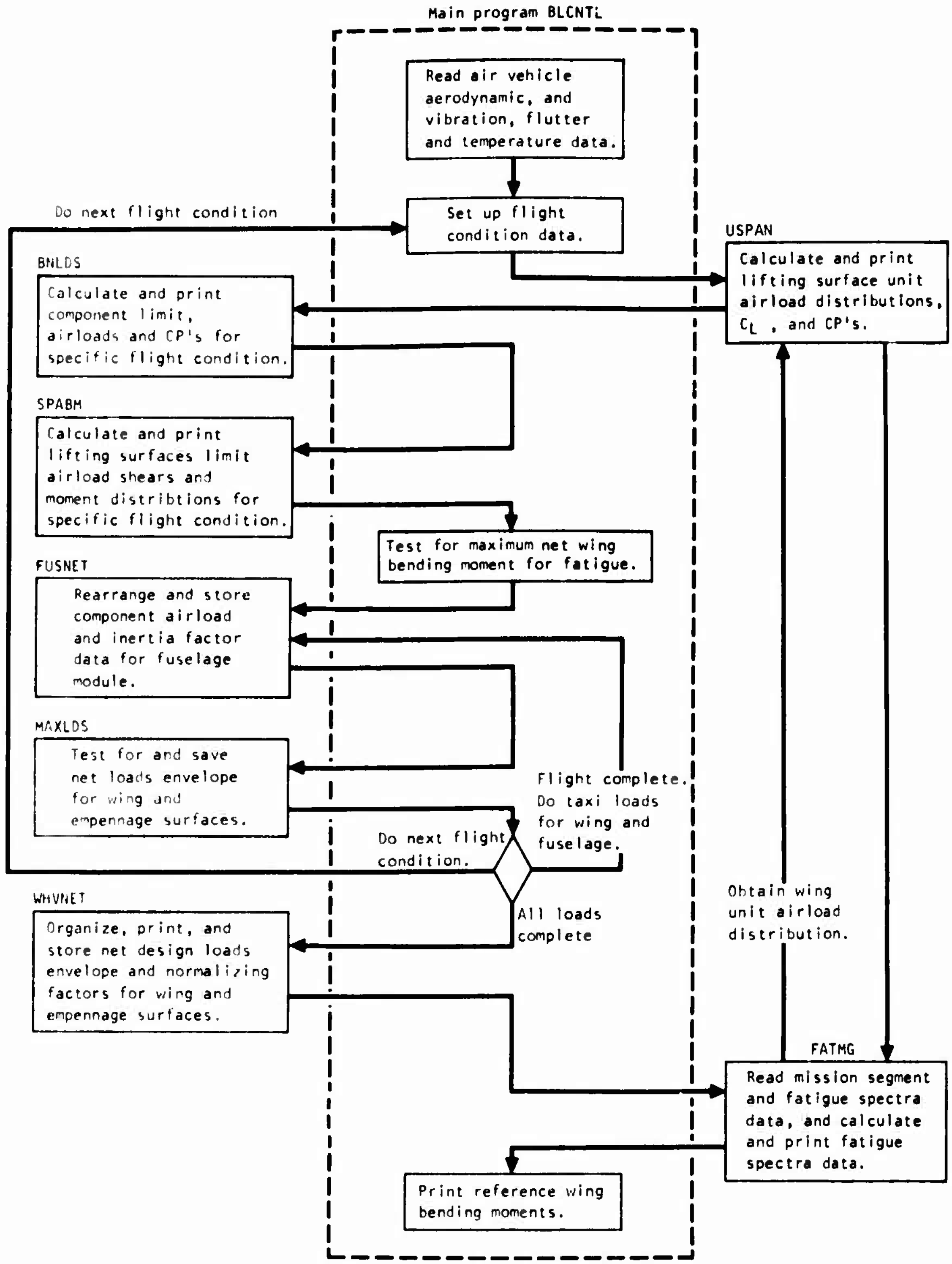


Figure 9. Logical flow diagram for airload module.

Array	Subroutine
DUMMY	FATMG
FUS	FUSNET
RATIO	WHVNET
WHVLID	WHVNET
WD	MAXLDS

Description of these arrays, as well as other program region arrays, are presented with the subroutine descriptions.

COMMON

Common consists of 5,895 cells which are divided into the major regions shown in Table 20. Table 21 presents an alphabetical listing of arrays and variables within the common region. Type designates whether variable is input (I) or calculated (C). When the variables in this table are subsets of larger arrays, the higher order array is referenced in brackets.

Tables 22 through 60 are maps of those arrays that have specific significance which are not explained in the alphabetical listing. Certain arrays and variables are only pertinent within a single routine; in which case, these variables are included in the discussion of the applicable routine.

LABELED COMMON

Labeled common arrays are used to transfer program control words and certain vehicle design data. These arrays are as follows:

- XMISC (Block MISC) - This array is used to transmit program controls and certain vehicle design data as shown in Table 61.

- IP (Block IPRINT) - This array is used to transmit print control, indicators to various subroutines as shown in Table 62. When this name (IP) is in conflict with common region variables, the name IQ is used.

MASS STORAGE FILES

Mass storage file records used by this program are shown in Table 63. Variables in these records are discussed in the common region tables or with the originating routine discussions.

TABLE 20. COMMON ARRANGEMENT

Common Location	Variable Name	Description
1		Reserved for future expansion
.	.	
.	.	
.	.	
99		
100	DT(1)	Permanent file aerodynamic data (record 1)
.	.	
.	.	
.	.	
155	DT(56)	
156	DB(1)	Permanent file subsonic aerodynamic data (record 2)
.	.	
.	.	
.	.	
1008	DB(853)	
1009	DF(1)	Permanent file deflected flap aerodynamic data (record 3)
.	.	
.	.	
.	.	
1154	DF(146)	
1155	DP(1)	Permanent file supersonic aerodynamic data (record 4)
.	.	
.	.	
.	.	
1888	DP(734)	
1889	DS(1)	Permanent file or input blocked mission segment tables (record 5)
.	.	
.	.	
.	.	
2176	DS(288)	
2177	DE(1)	Permanent file maneuver load factor spectra tables (record 6)
.	.	
.	.	
.	.	
2516	DE(340)	

TABLE 20. COMMON ARRANGEMENT (CONT)

Common Location	Variable Name	Description
2517	DI(1)	Permanent file taxi load factor spectra tables (record 7)
.	.	
.	.	
.	.	
2576	DI(60)	
2577	DG(1)	Permanent file turbulence field parameters (record 8)
.	.	
.	.	
.	.	
2648	DG(72)	
2649	DR(1)	Permanent file gust response factors (record 9)
.	.	
.	.	
.	.	
2757	DR(109)	
2758	BC(1)	Air vehicle design data (record 22)
.	.	
.	.	
.	.	
2952	BC(195)	
2953	BB(1)	Air vehicle load condition criteria
.	.	
.	.	
.	.	
2972	BB(20)	
2973	BS(1)	Basic program scratch array
.	.	
.	.	
.	.	
2992	BS(20)	
2993	BD(1)	Program scratch array
.	.	
.	.	
.	.	
3152	BD(160)	

TABLE 20. COMMON ARRANGEMENT (CONT)

Common Location	Variable Name	Description
3153	BU(1)	Unit spanwise loading tables
.	.	
.	.	
.	.	
3380	BU(228)	
3381	BO(1)	Air vehicle loading parameters and surface airload shear, bending moment, and torque. Also, fatigue spectra data.
.	.	
.	.	
.	.	
4000	BO(620)	
4001		Reserved for future expansion
.	.	
.	.	
.	.	
4200		
4201	ND(1)	Storage region for indicators and counters
.	.	
.	.	
.	.	
4400	ND(200)	
4401	WLD(1)	Structural component normalized inertia loads array
.	.	
.	.	
.	.	
4700	WLD(300)	
4701	IDUM(1)	Net design load condition indicator array
.	.	
.	.	
.	.	
4832	IDUM(132)	
4833	SAVE(1)	Design airloads array
.	.	
.	.	
.	.	
4964	SAVE(132)	

TABLE 20. COMMON ARRANGEMENT (CONT)

Common Location	Variable Name	Description
4965	XNET(1)	Net design loads array normalized to room temperature reference.
.	.	
.	.	
.	.	
5096	XNET(132)	
5097	RNZ(1)	Load factor normalizing factor array
.	.	
.	.	
.	.	
5228	RNZ(132)	
5229	RC(1)	Wing content normalizing factor array
.	.	
.	.	
.	.	
5272	RC(44)	
5273	SVF(1)	Ambient condition, temperature, and structural component material property data array
.	.	
.	.	
.	.	
5452	SVF(180)	
5453	STEMPW(1)	Wing material allowable at each design load condition
.	.	
	.	
.	.	
5475	STEMPW(23)	
5476	STEMPH(1)	Horizontal tail material allowable at each design load condition
.	.	
.	.	
.	.	
5498	STEMPH(23)	
5499	STEMPV(1)	Vertical tail material allowable at each design load condition
.	.	
.	.	
.	.	
5521	STEMPV(23)	

TABLE 20. COMMON ARRANGEMENT (CONCL)

Common Location	Variable Name	Description
5522	DUM(1)	Design airloads array normalized to reference temperature
.	.	
.	.	
.	.	
5719	DUM(198)	
5720	SAVET(1)	Reserved for torque evaluation
.	.	
.	.	
.	.	
5785	SAVET(66) .	

TABLE 21. COMMON REGION VARIABLE LIST

Var Name	Size	Common Loc	Type	Description	Subroutine Reference
ALT	23	3581	C	Vehicle altitude at load condition (BO)	BLCNTL
BB	20	2953	C	Vehicle design criteria at load conditions or at blocked mission segment in subroutine FATMG (refer to Table 22)	BLCNTL, USPAN, BNLDS, SPABM, FUSNET, FATMG. MAXLDS
BC	195	2758	I	Vehicle design data (refer to Table 23)	BLCNTL, USPAN, BNLDS, SPABM, MAXLDS, FUSNET, FATMG
BD	160	2993	C	Scratch array (refer to subroutine discussions)	USPAN, BNLDS, FATMG
BMH	11	4646	I	Horizontal tail and contents 1 g inertia bending moment (WLD)	MAXLDS
BMV	11	4679	I	Vertical tail and content 1 g inertia bending moment (WLD)	MAXLDS
BMW2	11	4481	I	Wing only 1 g inertia bending moment for wings fixed or forward (WLD)	MAXLDS
BM12	11	4547	I	Wing and content 1 g inertia bending moment at BFDW for wings fixed or aft (WLD)	MAXLDS
BM2G	11	4415	I	Wing net bending moment at 2 g taxi at MDW for wings fixed or forward (WLD)	MAXLDS
BM21	11	4514	I	Wing and content 1 g inertia bending moment at MDW for wings fixed or forward (WLD)	MAXLDS
BM22	11	4580	I	Wing and content 1 g inertia bending moment at BFDW for wings fixed or forward (WLD)	MAXLDS
BM23	11	4613	I	Wing and content 1 g inertia bending moment at LDW for wings fixed or forward (WLD)	MAXLDS

TABLE 21. COMMON REGION VARIABLE LIST (CONT)

Var Name	Size	Common Loc	Type	Description	Subroutine Reference
BO	620	3381	C	Component airloads, CP's, and vehicle inertia factors (refer to Table 24)	BLCNTL, BNLDS, SPABM, MAXLDS FUSNET
BO	620	3381	C	Spectra bending moment tables (refer to Table 75)	FATMG
BS	20	2973	C	Scratch array (refer to subroutine discussions)	USPAN, BNLDS, SPABM, FATMG
BU	228	3153	C	Unit spanwise loading tables (refer to Table 25)	USPAN, BNLDS, SPABM, FATMG
CMN	1	2962	C	Vehicle mach number at load condition (BB)	USPAN
DB	853	156	I	Permanent file subsonic aerodynamic data (refer to Table 26)	BLCNTL, USPAN
DE	340	2177	I	Permanent file maneuver load factor spectra tables (refer to Table 29)	FATMG
DF	146	1009	I	Permanent file deflected flap aerodynamic data (refer to Table 35)	BLCNTL, USPAN, BNLDS
DG	72	2577	I	Permanent file turbulence field parameters (refer to Table 37)	FATMG
DI	60	2517	I	Permanent file taxi load factor spectra tables (refer to Table 38)	FATMG
DP	734	1155	I	Permanent file supersonic aerodynamic data (refer to Table 39)	BLCNTL, USPAN
DR	109	2649	I	Permanent file gust response factors (refer to Table 41)	FATMG
DS	288	1889	I	Permanent file or input blocked mission segment tables (refer to Table 43)	FATMG
DT	56	100	I	Permanent file aerodynamic data (refer to Table 50)	BLCNTL, USPAN

TABLE 21. COMMON REGION VARIABLE LIST (CONT)

Var Name	Size	Common Loc	Type	Description	Subroutine Reference
DUM	198	5522	C	Design airloads array normalized to reference design temperature (refer to Table 51)	WHVNET
DX	15	3058	C	Normal distance from load reference to local CP (BD)	USPAN
ED	5	3023	C	Normalized spanwise stations for tabulated data (BD)	USPAN
ES	15	3028	C	Normalized spanwise stations for load evaluation	USPAN
I	1	4301	C	Scratch counter and load condition counter (ND)	BLCNTL, MAXLDS, FUSNET
I	1	4332	C	Scratch counter (ND)	USPAN
I	1	4340	C	Scratch counter (ND)	FCODM2
I	1	4351	C	Scratch counter (ND)	BNLDS
I	1	4355	C	Scratch counter (ND)	SPABM
I	1	4364	C	Scratch counter (ND)	FATMG
ID	1	4354	C	Surface indicator (ND) 1 = wing (basic) 2 = deflected flaps 3 = horizontal tail 4 = dual vertical tail 5 = single vertial tail 6 = T-type tail	SPABM

TABLE 21. COMMON REGION VARIABLE LIST (CONT)

Var Name	Size	Common Loc	Type	Description	Subroutine Reference
IDUM	132	4701	C	Net design load condition indicators (refer to Table 52)	BLCNTL, MAXLDS, WHVNET
IN	1	4305	C	Load calculation control (ND)	BLCNTL
IP	1	4337	C	Wing type and position indicator (ND)	USPAN, BNLDS, SPABM
J	1	4333	C	Scratch counter (ND)	USPAN
J	1	4344	C	Data point location counter (ND)	CODIM2
J	1	4352	C	Scratch counter (ND)	BNLDS
J	1	4356	C	Scratch counter (ND)	SPABM
J	1	4365	C	Scratch counter (ND)	FATMG
JJ	1	4345	C	Data point region indicator (ND)	CODIM2
K	1	4334	C	Scratch counter (ND)	USPAN
K	1	4341	C	Scratch counter (ND)	FCODM2
K	1	4346	C	Scratch counter (ND)	CODIM2
K	1	4353	C	Scratch counter (ND)	BNLDS
K	1	4357	C	Scratch counter (ND)	SPABM
K	1	4366	C	Scratch counter (ND)	FATMG
L	1	4335	C	Scratch counter (ND)	USPAN
L	1	4342	C	Curve family data location counter (ND)	FCODM2
L	1	4347	C	Scratch counter (ND)	CODIM2
L	1	4358	C	Scratch counter (ND)	SPABM
L	1	4367	C	Scratch counter (ND)	FATMG

TABLE 21. COMMON REGION VARIABLE LIST (CONT)

Var Name	Size	Common Loc	Type	Description	Subroutine Reference
M	1	4348	C	Scratch counter (ND)	CODIM2
M	1	4349	C	Scratch counter (ND)	USPAN
M	1	4359	C	Scratch counter (ND)	SPABM
M	1	4368	C	Scratch counter (ND)	FATMG
NA	1	4213	C	Air vehicle category indicator (ND) 1 = fighter, F 2 = attack, A 3 = tactical bomber, BI 4 = strategic bomber, BII 5 = cargo assault, CA 6 = cargo transport, CT	BLCNTL, FATMG
ND	200	4201	C	Storage region for basic load controls, indicators, and counters (refer to Table 53)	All except for ATMOS
NF	1	4308	C	Loads distribution calculation control (ND) -1 = all surfaces 1 = wing only, flaps up	BLCNTL, USPAN, FATMG
NG	1	4361	C	Scratch counter (ND)	FATMG
NHOR	1	5437	I	Number of library values in the horizontal tail stress, G, temperature tables (SVF)	MAXLDS
NI	1	4306	C	Load condition grouping indicator (ND)	BLCNTL, BNLDS
NN	1	4362	C	Scratch counter (ND)	FATMG
NS	1	4360	C	Mission segment counter (ND)	FATMG
NT	1	4336	C	Surface indicator (ND)	USPAN
NT	1	4350	C	Surface indicator (ND)	BNLDS

TABLE 21. COMMON REGION VARIABLE LIST (CONT)

Var Name	Size	Common Loc	Type	Description	Subroutine Reference
NVER	1	5451	I	Number of library values in the vertical tail stress, G, temperature tables (SVF)	MAXLDS
NWING	1	5423	I	Number of library values in the wing stress, G, temperature tables (SVF)	MAXLDS
NY	1	4363	C	Mission segment type for DE array file access (ND)	FATMG
N1	1	4343	C	Number of data points describing the function (ND)	CODIM2
N3	1	4338	C	Curve value counter (ND)	FCODM2
N4	1	4339	C	Number of curve interpolations (ND)	FCODM2
POSNZ	1	4402	I	Maximum positive maneuver load factor (WLD)	MAXLDS
PSI	23	5273	I	Ambient pressure at load conditions (SVF)	BLCNTL
RC	44	5229	C	Wing content normalizing factors (refer to Table 54)	BLCNTL, MAXLDS, WHVNET
RNZ	132	5097	C	Load factor normalizing factors (refer to Table 55)	BLCNTL, MAXLDS, WHVNET

TABLE 21. COMMON REGION VARIABLE LIST (CONT)

Var Name	Size	Common Loc	Type	Description	Subroutine Reference
SAVE	132	4833	C	Design airload shears and bending moments (refer to Table 56)	BLCNTL, MAXLDS, WHVNET
SAVET	66	5720	C	Design airload torques (refer to Table 57)	MAXLDS, WHVNET
SFLUX	23	5342	I	Sun flux at load conditions (SVF)	BLCNTL
STEMPH	23	5476	C	Horizontal tail material compression yield strength at load conditions	BLCNTL, MAXLDS, WHVNET
STEMPV	23	5499	C	Vertical tail material compression yield strength at load conditions	BLCNTL, MAXLDS, WHVNET
STEMPW	23	5453	C	Wing material compression yield strength at load conditions	BLCNTL, MAXLDS, WHVNET
STH	6	5425	I	Horizontal tail material compression yield strength at library temperatures (SVF)	MAXLDS
STV	6	5439	I	Vertical tail material compression yield strength at library temperatures (SVF)	MAXLDS
STW	6	5411	I	Wing material compression yield strength at library temperatures (SVF)	MAXLDS
SVF	290	5273	I	Ambient condition, temperature, and structural component material property data array (refer to Table 58)	BLCNTL, MAXLDS, WHVNET, FUSNET
S80H	1	5438	I	Horizontal tail material compression yield strength at 80° F (SVF)	MAXLDS
S80V	1	5452	I	Vertical tail material compression yield strength at 80° F (SVF)	MAXLDS
S80W	1	5424	I	Wing material compression yield strength at 80° F (SVF)	MAXLDS, WHVNET

TABLE 21. COMMON REGION VARIABLE LIST (CONT)

Var Name	Size	Common Loc	Type	Description	Subroutine Reference
TEMPH	6	5431	I	Horizontal tail material temperature, °F, for library values of compression yield strength and shear modulus (SVF)	MAXLDS
TEMPV	6	5445	I	Vertical tail material temperature, °F, for library values of compression yield strength and shear modulus (SVF)	MAXLDS
TEMPW	6	5417	I	Wing material temperature, °F, for library values of compression yield strength and shear modulus (SVF)	MAXLDS
TLOCAL	23	5296	I	Ambient temperature at load conditions, °R (SVF)	BLCNTL
TSKINF	23	5388	I	Equilibrium structure temperature at load conditions, °F (SVF)	BLCNTL, WHVNET MAXLDS, FUSNET
TSKINR	23	5365	I	Equilibrium structure temperature at load conditions, °R (SVF)	BLCNTL
TTOTAL	23	5319	I	Total temperature at load conditions, °R (SVF)	BLCNTL
T2G	11	4426	I	Wing net torque at 2g taxi at MDW for wing fixed or forward	MAXLDS
VT	1	2966	C	Vertical tail identification (BB) 5 = single tail 6 = dual tail 7 = T-type tail	USPAN
VH	11	4635	I	Horizontal tail content 1 g inertia shear (WLD)	MAXLDS
VV	11	4668	I	Vertical tail content 1 g inertia shear (WLD)	MAXLDS
VW2	11	4470	I	Wing only 1 g inertia shear for wings fixed or forward (WLD)	MAXLDS

TABLE 21. COMMON REGION VARIABLE LIST (CONCL)

Var Name	Size	Common Loc	Type	Description	Subroutine Reference
V12	11	4536	I	Wing and content 1 g inertia shear at BFDW for wings fixed or aft (WLD)	MAXLDS
V2G	11	4404	I	Wing net shear at 2 g taxi at MDW for wings fixed or forward (WLD)	MAXLDS
V21	11	4503	I	Wing and content 1 g inertia shear at MDW for wings fixed or forward (WLD)	MAXLDS
V22	11	4569	I	Wing and content 1 g inertia shear at BFDW for wings fixed or forward (WLD)	MAXLDS
V23	11	4602	I	Wing and content 1 g inertia shear at LDW for wings fixed or forward (WLD)	MAXLDS
WLD	300	4401	I	Structural component normalized inertia loads array (refer to Table 59)	BLCNTL, MAXLDS
XMACH	23	3604	C	Vehicle mach number at load conditions (BO)	BLCNTL
XNET	132	4965	C	Net design loads array normalized to room temperature reference (refer to Table 60)	BLCNTL, MAXLDS, WHVNET
XNEGNZ	1	4403	I	Maximum negative maneuver load factor (WLD)	MAXLDS
YA	5	2993	C	Subsonic lift curve slope parameter (BD)	USPAN
YB	20	2998	C	Spanwise loading parameters versus taper ratios and span stations (BD)	USPAN
YC	5	3018	C	Spanwise loading parameter versus span stations (BD)	USPAN
YS	15	3043	C	Interpolated or unitized spanwise loading parameter at load evaluation stations (BD)	USPAN

TABLE 22. BB ARRAY VARIABLES

LOC	Description	Subroutine Reference
1	Vehicle weight, lb	BLCNTL, BNLDS, FATMG, MAXLDS
2	Vehicle CG, fuselage station, in.	BLCNTL, BNLDS
3	Vehicle pitch inertia, slug-ft^2	BLCNTL, BNLDS
4	Vehicle yaw inertia, slug-ft^2	BLCNTL, BNLDS
5	Flap deflection, deg	BLCNTL, USPAN, BNLDS, SPABM
6	Vehicle vertical load factor	BLCNTL, BNLDS
7	Vehicle pitch acceleration, rad/sec^2	BLCNTL, BNLDS
8	Vehicle yaw acceleration, rad/sec^2	BLCNTL, BNLDS
9	Vehicle altitude	BLCNTL, BNLDS, SPABM, FATMG, FUSNET
10	Vehicle mach number, also FORTRAN symbol CMN	BLCNTL, BNLDS, USPAN, SPABM, FATMG, FUSNET
11	Fuselage identification = 0.0	BLCNTL
12	Wing identification 1 = fixed wing 2 = variable sweep wing, forward position 3 = variable sweep wing, aft position	BLCNTL, USPAN, FATMG
13	Horizontal tail identification = 4.0	BLCNTL, SPABM
14	Vertical tail identification/also FORTRAN symbol VT 5 = single tail 6 = dual tail 7 = T-type tail	BLCNTL, SPABM, USPAN

TABLE 22. BB ARRAY VARIABLES (CONCL)

Loc	Description	Subroutine Reference
15	Partial load condition designation - vehicle class and condition number	BLCNTL
16	Vehicle mach number at previous load condition	BLCNTL
17	Swept δX-station of wing CP at wing-body interface, in.	USPAN
18	Swept δX-station of flap increment CP at wing-body interface, in.	USPAN
19	Swept δX-station of horizontal tail CP at horizontal tail-body interface, in.	USPAN
19	Unit airload bending moment unswept at side of fuselage from segment 1 for use in segment 11	FATMG
20	Swept δX-station of vertical tail CP at vertical tail body interface, in.	USPAN
20	Unit airload bending moment swept at outboard station from segment 1 for use in segment 11	FATMG

NOTE: BB array starts at common location 2953.

TABLE 23. BC ARRAY VARIABLES

Loc	Description	Subroutine Reference
1	Maximum design weight (MDW), lb	BLCNTL, MAXLDS
2	Vehicle X-CG with wings forward at MDW, fuselage station, in.	BLCNTL, MAXLDS
3	Vehicle X-CG with wings aft at MDW, fuselage station, in.	BLCNTL
4	Basic flight design weight (BFDW), (MIL-A-008860A, para 6.2.1.3), lb	BLCNTL
5	Vehicle X-CG with wings forward at BFDW, fuselage station, in.	BLCNTL, MAXLDS
6	Vehicle X-CG with wings aft at BFDW, fuselage station, in.	BLCNTL, MAXLDS
7	Vehicle pitch inertia with wings forward at BFDW, slug-ft^2	BLCNTL
8	Vehicle pitch inertia with wings aft at BFDW, slug-ft^2	BLCNTL
9	Vehicle yaw inertia with wings forward at BFDW, slug-ft^2	BLCNTL
10	Vehicle yaw inertia with wings aft at BFDW, slug-ft^2	BLCNTL
11	Landing design weight (LDW), (MIL-A-008860A, para 6.2.1.5), lb	BLCNTL
12	Vehicle X-CG with wings forward at LDW, fuselage station, in	BLCNTL, MAXLDS
13	Positive maneuver load factor ($+N_z$) at BFDW -subsonic (MIL-A-008861A, Table 1)	BLCNTL, FATMG
14	Positive maneuver load factor ($+N_z$) at BFDW -supersonic (MIL-A-008861A, Table 1)	BLCNTL

TABLE 23. BC ARRAY VARIABLES (CONT)

Loc	Description	Subroutine Reference
15	Negative maneuver load factor ($-N_z$) at BFDW (MIL-A-008861A, Table 1)	BLCNTL
16	Flaps down maneuver load factor ($+N_z$) (MIL-A-008861A, para 3.19.3)	BLCNTL
17	Pitching acceleration at M_L for BFDW, rad/sec^2	BLCNTL
18	Yawing acceleration at M_L for BFDW, rad/sec^2	BLCNTL
19	Altitude at point 1 on speed profile with wing fixed or aft, ft	BLCNTL
20	Altitude at point 2 on speed profile with wing fixed or aft, ft	BLCNTL
21	Altitude at point 3 on speed profile with wing fixed or aft, ft	BLCNTL
22	Level-flight maximum speed (M_H) at altitude 1 with wing fixed or aft, Mach number	BLCNTL
23	Level-flight maximum speed (M_H) at altitude 2 with wing fixed or aft, Mach number	BLCNTL
24	Level-flight maximum speed (M_H) at altitude 3 with wings fixed or aft, Mach number	
25	Altitude at point 1 on speed profile with wings forward (var sweep only), ft	BLCNTL
26	Altitude at point 2 on speed profile with wings forward (var sweep only), ft	BLCNTL
27	Altitude at point 3 on speed profile with wings forward (var sweep only), ft	
28	Level-flight maximum speed (M_H) at altitude 1 with wings forward, Mach number	BLCNTL
29	Level-flight maximum speed (M_H) at altitude 2 with wings forward, Mach number	BLCNTL

TABLE 23. BC ARRAY VARIABLES (CONT)

Loc	Description	Subroutine Reference
30	Level-flight maximum speed (M_H) at altitude 3 with wings forward, mach number	
31	Minimum speed flaps up (V_{SO}) at MDW (MIL-A-008860A, para 6.2.2), knots	BLCNTL
32	Minimum speed flaps down (V_{SL}) at LDW (MIL-A-008860A, para 6.2.2), knots	BLCNTL
33	Distance from X-reference point to body nose, in.	BNLDS
34	Length of nose, in.	BNLDS
35	Nose volume, $in.^3$	BNLDS
36	Equivalent maximum nose radius, in.	BNLDS
37	Body half-width at wing-body interface, in.	USPAN, SPABM
38	Wing leading edge sweep (wing fixed or aft), deg	USPAN
39	Wing reference axis sweep (wing fixed or aft), deg	USPAN, SPABM
40	Wing leading edge apex (wing fixed or aft), fuselage station, in.	BNLDS, FUSNET
41	Wing chord at apex (wing fixed or aft), in.	USPAN
42	Wing taper ratio (wing fixed or aft)	USPAN
43	Wing aspect ratio (wing fixed or aft)	USPAN
44	Wing area (wing fixed or aft), ft^2	BNLDS, FATMG
45	Wing span (wing fixed or aft), ft	USPAN, BNLDS, SPABM, FATMG
46	Wing span station 1 for weight analysis (wing fixed or aft), in.	USPAN
.	Outboard to	

TABLE 23. BC ARRAY VARIABLES (CONT)

Loc	Description	Subroutine Reference
56	Wing span station 11 for weight analysis (wing fixed or aft), in.	USPAN
57	Fraction of chord (X/C) of wing reference axis (wing fixed or aft)	USPAN
58	Not used	
.		
68	Not used	
69	Wing leading edge sweep (wing forward, variable sweep only), deg	USPAN
70	Wing reference axis sweep (wing forward, variable sweep only), deg	USPAN, SPABM
71	Wing leading edge apex (wing forward, variable sweep only), fuselage station, in.	BNLDS, FUSNET
72	Wing chord at apex (wing forward, variable sweep only), in.	USPAN
73	Wing taper ratio (wing forward, variable sweep only)	USPAN
74	Wing aspect ratio (wing forward, variable sweep only)	USPAN
75	Wing area (wing forward, variable sweep only), ft^2	BNLDS, FATMG
76	Wing span (wing forward, variable sweep only), ft	USPAN, BNLDS, SPABM, FATMG
77	Wing span station 1 for weight analysis (wing forward, variable sweep only), in.	USPAN
.	Outboard to	
87	Wing span station 11 for weight analysis (wing forward, variable sweep only), in	USPAN

TABLE 23. BC ARRAY VARIABLES (CONT)

Loc	Description	Subroutine Reference
88	Fraction of chord (X/C) of reference axis (wing forward, variable sweep only)	USPAN
89	Not used	
.		
99	Not used	
100	Wing station (Y_{FI}) of inboard end of flap (wing fixed or forward), in.	USPAN
101	Wing station (Y_{FO}) of outboard end of flap (wing fixed or forward), in.	USPAN
102	Fraction of chord (C_F/C) of flap chord (wing fixed or forward)	USPAN, BNLDS
103	Required flap deflection (wing fixed or forward), deg	BLCNTL
104	Z-distance from vertical tail root to horizontal tail plane, in.	SPABM
105	Horizontal tail leading edge sweep, deg	USPAN
106	Horizontal tail reference axis sweep, deg	USPAN, SPABM
107	Horizontal tail leading edge apex, fuselage station, in.	BNLDS, MAXLDS
108	Horizontal tail chord at apex, in.	USPAN, MAXLDS
109	Horizontal tail taper ratio	USPAN
110	Horizontal tail aspect ratio	USPAN
111	Horizontal tail area, ft^2	BNLDS
112	Horizontal tail span, ft	USPAN, SPABM

TABLE 23. BC ARRAY VARIABLES (CONT)

Loc	Description	Subroutine Reference
113	Body half-width at horizontal-body interface, in.	USPAN, SPABM
114	Horizontal tail span station 1 for weight analysis, in.	USPAN
.	Outboard to	
124	Horizontal tail span station 11 for weight analysis, in.	USPAN
125	Fraction of chord (X/C) of horizontal tail reference axis	USPAN
126	Not used	
.		
136	Not used	
137	Vertical tail leading edge sweep, deg	USPAN
138	Vertical tail reference axis sweep, deg	USPAN, SPABM
139	Vertical tail leading edge apex, fuselage station, in.	BNLDS, MAXLDS
140	Vertical tail chord at apex, in.	USPAN, MAXLDS
141	Vertical tail taper ratio	USPAN
142	Vertical tail aspect ratio	USPAN
143	Vertical tail area, ft^2	BNLDS
144	Vertical tail span, ft	USPAN, SPABM
145	Z-distance vertical tail root to vertical tail-body interface, in.	USPAN, SPABM
146	Vertical tail span station 1 for weight analysis, in.	USPAN
.	Outboard to	

TABLE 23. BC ARRAY VARIABLES (CONT)

Loc	Description	Subroutine Reference
156	Vertical tail span station 11 for weight analysis, in.	USPAN
157	Fraction of chord (X/C) of vertical tail reference axis	USPAN
158	Z-coordinate of vertical tail root, in.	BNLDS
159 • 162	Not used To Not used	
163	Carryover lift reduction factor - wing	BLCNTL
164	Carryover lift reduction factor - horizontal tail	BLCNTL
165	Carrover lift reduction factor vertical tail	BLCNTL
166	Limit speed (M_L) at altitude 1 with wings fixed or aft, mach number	BLCNTL
167	Limit speed (M_L) at altitude 2 with wings fixed or aft, mach number	BLCNTL
168	Limit speed (M_L) at altitude 3 with wings fixed or aft, mach number	BLCNTL
169	Air vehicle service life, hours	FATMG
170	Air vehicle service landings, number of landings	FATMG
171	Unswept wing outboard station for fatigue evaluation, in.	FATMG
172	Weight ratio 1 ($W1/W_{OF}$) for which inertia moment is calculated	FATMG
173	Weight ratio 2 ($W2/W_{OF}$) for which inertia moment is calculated	FATMG
174	Weight ratio 3 (W_3/W_{OF}) for which inertia moment is calculated	FATMG
175	Unswept moment at side of body per unit load factor, at weight ratio 1, for wing fixed or aft, in.-lb	FATMG

TABLE 23. BC ARRAY VARIABLES (CONT)

Loc	Description	Subroutine Reference
176	Unswept moment at side of body per unit load factor, at weight ratio 2, for wing fixed or aft, in.-lb	FATMG
177	Unswept moment at side of body per unit load factor, at weight ratio 3, for wing fixed or aft, in.-lb	FATMG
178	Swept moment at outboard station per unit load factor, at weight ratio 1, for wing fixed or aft, in.-lb	FATMG
179	Swept moment at outboard station per unit load factor, at weight ratio 2, for wing fixed or aft, in.-lb	FATMG
180	Swept moment at outboard station per unit load factor, at weight ratio 3, for wing fixed or aft, in.-lb	FATMG
181	Unswept moment at side of body per unit load factor, at weight ratio 1, for wing forward (variable sweep only), in.-lb	FATMG
182	Unswept moment at side of body per unit load factor, at weight ratio 2, for wing forward (variable sweep only), in.-lb	FATMG
183	Unswept moment at side of body per unit load factor, at weight ratio 3, for wing forward (variable sweep only), in.-lb	FATMG
184	Swept moment at outboard station per unit load factor, at weight ratio 1, for wing forward (variable sweep only), in.-lb	FATMG
185	Swept moment at outboard station per unit load factor, at weight ratio 2, for wing forward (variable sweep only), in.-lb	FATMG
186	Swept moment at outboard station per unit load factor, at weight ratio 3, for wing forward (variable sweep only), in.-lb	FATMG
187	Take off weight (W_{OF}) for fatigue, lb	FATMG

TABLE 23. BC ARRAY VARIABLES (CONCL)

Loc	Description	Subroutine Reference
188	Landing weight (W_{LF}) for fatigue, lb	FATMG
189	Not used	
.		
200	Not used	

NOTE: BC array starts at common location 2758.

TABLE 24. BO ARRAY VARIABLES

Loc	Engrg Symbol	Description	Subroutine Reference
1	ACNWV	Condition identification code A = Air vehicle class 1 = fighter 2 = attack 3 = BI 4 = BII 5 = CA 6 = CT CN = Condition number (1 - 23) W = Wing indicator 1 = fixed wing 2 = variable sweep wing - forward 3 = variable sweep wing - aft V = Vertical tail indicator 5 = single tail 6 = dual tail 7 = T-type tail	BLCNTL, BNLDS, SPABM
2	ACNF	Fuselage identification F = 0.0	BLCNTL
3	P_{ZN}	Nose lift, lb	BNLDS, FUSNET
4	P_{YN}	Lateral load on nose, lb	BNLDS
5	$\overline{X}_N$	X-coordinate of nose lift CP, in.	BNLDS, FUSNET
6	$P_{ZW(B)/2}$	Wing lift in presence of body (outer panel) per side, lb	BNLDS, FUSNET
7	$\overline{Y}_{W(B)}$	Y-coordinate of wing lift in presence of body, in.	BNLDS, FUSNET
8	$\overline{X}_{W(B)}$	X-coordinate of wing lift in presence of body, in.	BNLDS, FUSNET

TABLE 24. BO ARRAY VARIABLES (CONT)

Loc	Engrg Symbol	Description	Subroutine Reference
9	$P_{ZB(W)}$	Body lift in presence of wing, lb	BNLDS, FUSNET
10	$\bar{X}_{B(W)}$	X-coordinate of body lift, in.	BNLDS, FUSNET
11	$P_{ZH/2}$	Horizontal tail lift per side, lb	BNLDS, SPABM, FUSNET
12	$\bar{Y}_H$	Y-coordinate of horizontal tail lift, in.	BNLDS, SPABM, FUSNET
13	$\bar{X}_H$	X-coordinate of horizontal tail lift, in.	BNLDS, FUSNET
14	ΔM_{XH}	Unsymmetrical horizontal tail rolling moment, in.-lb	BNLDS
15	P_{YV}	Lateral load on vertical tail per vehicle, lb	BNLDS, FUSNET, SPABM
16	$\bar{Z}_V$	Z-coordinate of vertical tail load, in.	BNLDS, FUSNET
17	$\bar{X}_V$	X-coordinate of vertical tail load, in.	BNLDS, FUSNET
18	N_Z	Vehicle vertical load factor	BLCNTL, BNLDS, MAXLDS, FUSNET
19	N_Y	Vehicle lateral load factor	BNLDS, MAXLDS, FUSNET
20	$\dot{Q}$	Vehicle pitch acceleration, rad/sec^2	BNLDS, MAXLDS, FUSNET
21	$\dot{R}$	Vehicle yaw acceleration, rad/sec^2	BNLDS, MAXLDS, FUSNET
22	ACNW	Wing identification	BLCNTL
23	Y_{BW}	Body half width at wing-body interface, in.	SPABM
24	$S_{ZW(B)}$	Wing shear at wing-body interface, lb	SPABM

TABLE 24. BO ARRAY VARIABLES (CONT)

Loc	Engrg Symbol	Description	Subroutine Reference
25	$M_{XW(B)}$	Moment at wing-body interface (unswept), in.-lb	SPABM, BLCNTL
26	$M_{YW(B)}$	Torque at wing-body interface (unswept), in.-lb	SPABM
27	$Y_{\Lambda W1}$	Swept wing station at tip, in.	SPABM
28	S_{ZW1}	Shear at swept tip station, lb	SPABM
29	$M_{X\Lambda W1}$	Moment at swept tip station, in.-lb	SPABM
30	$M_{Y\Lambda W1}$	Torque at swept tip station, in.-lb	SPABM
31	$Y\Lambda_{W2}$	Swept wing station 11 for weight analysis, in.	SPABM
32	S_{ZW2}	Shear at swept wing station 11, lb	SPABM, MAXLDS
33	$M_{X\Lambda W2}$	Moment at swept wing station 11, in.-lb	SPABM, MAXLDS
34	$M_{Y\Lambda W2}$	Torque at swept wing station 11, in.-lb	SPABM, MAXLDS
•		Inboard to	
67	$Y_{\Lambda W11}$	Swept wing station 2 for weight analysis, in.	SPABM
68	S_{ZW11}	Shear at swept wing station 2, lb	SPABM, MAXLDS
69	$M_{X\Lambda 11}$	Moment at swept wing station 2, in.-lb	SPABM, MAXLDS, BLCNTL
70	$M_{Y\Lambda 11}$	Torque at swept wing station 2, in.-lb	SPABM, MAXLDS
71	$Y_{\Lambda W12}$	Swept wing station 1 for weight analysis, in.	SPABM
72	S_{ZW12}	Shear at swept wing station 1, lb	SPABM, MAXLDS
73	$M_{X\Lambda 12}$	Moment at swept wing station 1, in.-lb	SPABM, MAXLDS

TABLE 24. BO ARRAY VARIABLES (CONT)

Loc	Engrg Symbol	Description	Subroutine Reference
74	$M_{Y\Lambda 12}$	Torque at swept wing station 1, in.-lb	SPABM, MAXLDS
75	ACNH	Horizontal tail identification H = 4.0	BLCNTL, SPABM
76	Y_{BH}	Body half width at horizontal tail-body interface, in.	SPABM
77	$S_{ZH(B)}$	Horizontal tail shear at tail-body interface, lb	SPABM
78	$M_{XH(B)}$	Moment at horizontal tail-body interface (unswept), in.-lb	SPABM
79	$M_{YH(B)}$	Torque at horizontal tail-body interface (unswept), in.-lb	SPABM
80	$Y_{\Lambda H1}$	Swept horizontal tail station at tip, in.	SPABM
81	S_{ZH1}	Shear at swept tip station, lb	SPABM
82	$M_{X\Lambda H1}$	Moment at swept tip station, in.-lb	SPABM
83	$M_{Y\Lambda H1}$	Torque at swept tip station, in.-lb	SPABM
84	$Y_{\Lambda H2}$	Swept horizontal tail station 11 for weight analysis, in.	SPABM
85	S_{ZHZ}	Shear at swept horizontal tail station 11, lb	SPABM, MAXLDS
86	$M_{X\Lambda H2}$	Moment at swept horizontal tail station 11, in.-lb	SPABM, MAXLDS
87	$M_{Y\Lambda H2}$	Torque at swept horizontal tail station 11, in.-lb	SPABM, MAXLDS
.		Inboard to	
124	$Y\Lambda_{H12}$	Swept horizontal tail station 1 for weight analysis, in.	SPABM

TABLE 24. BO ARRAY VARIABLES (CONT)

Loc	Engrg Symbol	Description	Subroutine Reference
125	S_{ZH12}	Shear at swept horizontal tail station 1, lb	SPABM, MAXLDS
126	M_{XAH12}	Moment at swept horizontal tail station 1, in.-lb	SPABM, MAXLDS
127	M_{YAH12}	Torque at swept horizontal tail station 1, in.-lb	SPABM, MAXLDS
128	ACNV	Vertical tail identification V = 5, single tail 6, dual tail 7, T-type tail	BLCNTL, SPABM
129	Z_{BV}	Z-distance vertical tail root to vertical tail-body interface, in.	SPABM
130	$S_{YV(B)}$	Vertical tail shear at tail-body interface, in.	SPABM
131	$M_{XV(B)}$	Moment at vertical tail-body interface, (unswept), in.-lb	SPABM
132	$M_{ZV(B)}$	Torque at vertical tail-body interface, (unswept), in.-lb	SPABM
133	$Z_{\Lambda V1}$	Swept vertical tail station at tip, in.	SPABM
134	S_{YV1}	Shear at tip station, lb	SPABM
135	$M_{X\Lambda V1}$	Moment at tip station, in.-lb	SPABM
136	$M_{Z\ V1}$	Torque at tip station, in.-lb	SPABM
137	$Z_{\Lambda V2}$	Swept vertical tail station 11 for weight analysis, in.	SPABM
138	S_{YV2}	Shear at swept vertical tail station 11, lb	SPABM, MAXLDS
139	$M_{X\Lambda V2}$	Moment at swept vertical tail station 11, in.-lb	SPABM, MAXLDS

TABLE 24. BO ARRAY VARIABLES (CONT)

Loc	Engrg Symbol	Description	Subroutine Reference
140	$M_{Z\Lambda V2}$	Torque at swept vertical tail station 11, in.-lb	SPABM, MAXLDS
		Inboard to	
177	$Z_{\Lambda 12}$	Swept vertical tail station 1 for weight analysis, in.	SPABM
178	S_{YV12}	Shear at swept vertical tail section 1, lb	SPABM, MAXLDS
179	$M_{X\Lambda V12}$	Moment at swept vertical tail station 1, in.-lb	SPABM, MAXLDS
180	$M_{Z\Lambda V12}$	Torque at swept vertical tail station 1, in.-lb	SPABM, MAXLDS
181	MDW	Maximum design weight, lb	MAXLDS
182	BFDW	Basic flight design weight, lb	MAXLDS
183		Total fuel at MDW, lb	MAXLDS
184		Incremental fuel expended from MDW to BFDW, lb	MAXLDS
185		Incremental payload expended from MDW to BFDW, lb	MAXLDS
186		Wing structure temperature, °F	MAXLDS
187		Horizontal tail structure temperature. °F	MAXLDS
188		Vertical tail structure temperature, °F	MAXLDS
189		Not used	
200		Not used	

TABLE 24. BO ARRAY VARIABLES (CONCL)

Loc	Engrg Symbol	Description	Subroutine Reference
201		Altitude at load condition 1, ft	BLCNTL
223		To	
223		Altitude at load condition 23, ft	BLCNTL
224		Mach number at load condition 1	BLCNTL
		To	
246		Mach number at load condition 23	BLCNTL
247		Not used	
		To	
620		Not used	

NOTE

1. BO array starts at common location 3381
2. This table does not apply to variables as they are used in subroutine FATMG. For subroutine FATMG variables, refer to Table 75.

TABLE 25. BU ARRAY VARIABLES

Loc	Engrg Symbol	Description	Subroutine Reference
1	$C_{L\alpha W}$	Wing lift curve slope, per radian	USPAN, BNLDS, FATMG
2	$K_{W(B)A}$	Fraction of wing shear on outboard panel in presence of body	USPAN, BNLDS, SPABM
3	$\bar{Y}_{W(B)A}$	Y-coordinate of wing outboard panel lift in presence of body, in.	USPAN, BNLDS
4	$\Delta\bar{X}_{W(B)A}$	X-distance (from leading edge apex) to wing outboard panel lift in presence of body, in.	USPAN, BNLDS
5	$\Delta X_{B(W)A}$	X-distance (from leading edge apex) to body lift in presence of wing, in.	USPAN, BNLDS
6	$US_{W(SOB)}$	Shear at wing-body interface due to unit panel lift, lb/lb	USPAN, SPABM
7	$UM_{XW(SOB)}$	Moment at wing-body interface (unswept) due to unit panel lift, in.-lb/lb	USPAN, SPABM, FATMG
8	$UM_{YW(SOB)}$	Torque at wing-body interface (unswept) due to unit panel lift, in.-lb/lb	USPAN, SPABM
9	η_{W1}	Fraction of semispan at tip (1.0)	USPAN, SPABM, FATMG
10	η_{W2}	Fraction of semispan of wing span station 11 for weight analysis	USPAN, SPABM, FATMG
11	η_{W3}	Fraction of semispan of wing span station 10 for weight analysis	USPAN, SPABM, FATMG
.		To	

TABLE 25. BU ARRAY VARIABLES (CONT)

Loc	Engrg Symbol	Description	Subroutine Reference
20	η_{W12}	Fraction of semispan of wing span station 1 for weight analysis	USPAN, SPABM, FATMG
21	η_{W13}	Fraction of semispan at root (0.0)	USPAN, FATMG
22	US_{W1}	Shear at wing tip due to unit panel lift, lb/lb	USPAN, SPABM
.		To	
34	US_{W13}	Shear at wing root due to unit panel lift, lb/lb	USPAN, SPABM
35	UM_{XW1}	Moment at wing tip (swept) due to unit panel lift, in.-lb/lb	USPAN, SPABM, FATMG
.		To	
47	UM_{XW13}	Moment at wing root (swept) due to unit panel lift, in.-lb/lb	USPAN, SPABM, FATMG
48	UM_{YW1}	Torque at wing tip (swept) due to unit panel lift, in.-lb/lb	USPAN, SPABM
.		To	
60	UM_{YW13}	Torque at wing root (swept) due to unit panel lift, in.-lb/lb	USPAN, SPABM
61	K_{BF}	Normalizing factor for deflected flap load distribution	USPAN, BNLDS
62	$K_{W(B)F}$	Fraction of wing shear on out-board panel due to deflected flap	USPAN, BNLDS, SPABM

TABLE 25. BU ARRAY VARIABLES (CONT)

Loc	Engrg Symbol	Description	Subroutine Reference
63	$\overline{Y}_{W(B)F}$	Y-coordinate of wing outboard panel lift due to deflected flap, in.	USPAN, BNLDS
64	$\Delta\overline{X}_{W(B)F}$	X-distance (from leading edge apex) to wing outboard panel lift due to deflected flap, in.	USPAN, BNLDS
65	$\Delta\overline{X}_{B(W)F}$	X-distnce (from leading edge apex) to body lift due to deflected flap, in.	USPAN, BNLDS
66	$US_{F(SOB)}$	Shear at wing- body interface due to unit panel lift from deflected flaps, lb/lb	USPAN, SPABM
67	$UM_{XF(SOB)}$	Moment at wing-body interface (unswept) due to unit panel lift from deflected flaps, in.-lb/lb	USPAN, SPABM
68	$UM_{YF(SOB)}$	Torque at wing-body interface (unswept) due to unit panel lift from deflected flaps, in.-lb/lb	USPAN, SPABM
69	US_{F1}	Shear at wing tip due to unit panel lift from deflected flaps, lb/lb	USPAN, SPABM
.		To	
81	US_{F13}	Shear at wing root due to unit panel lift from deflected flaps, lb/lb	USPAN, SPABM
82	UM_{XF1}	Moment at wing tip (swept) due to unit panel lift from defelected flaps, in.-lb/lb	USPAN, SPABM
.			

TABLE 25. BU ARRAY VARIABLES (CONT)

Loc	Engrg Symbol	Description	Subroutine Reference
94	UM_{XF13}	Moment at wing root (swept) due to unit panel lift from deflected flaps, in.-lb/lb	USPAN, SPABM
95	UM_{YF1}	Torque at wing tip (swept) due to unit panel lift from deflected flaps, in.-lb/lb	USPAN, SPABM
.		To	
107	UM_{YF13}	Torque at wing root (swept) due to unit panel lift from deflected flaps, in.-lb/lb	USPAN, SPABM
108	$C_{L\alpha H}$	Horizontal tail lift curve slope, per radian	USPAN, BNLDS
109	$K_{H(B)}$	Fraction of horizontal tail lift on outboard panel	USPAN, BNLDS, SPABM
110	$\overline{Y}_H$	Y-coordinate of horizontal tail lift (total), in.	USPAN, BNLDS
111	$\Delta\overline{X}_H$	X-distance (from leading edge apex) to horizontal tail lift (total), in.	USPAN, BNLDS
112	$US_{H(SOB)}$	Shear at horizontal tail-body interface due to unit panel lift, lb/lb	USPAN, SPABM
113	$UM_{XH(SOB)}$	Moment at horizontal tail-body interface (unswept) due to unit panel lift, in.-lb/lb	USPAN, SPABM
114	$UM_{YH(SOB)}$	Torque at horizontal tail-body interface (unswept) due to unit panel lift, in.-lb/lb	USPAN, SPABM

TABLE 25. BU ARRAY VARIABLES (CONT)

Loc	Engrg Symbol	Description	Subroutine Reference
115	η_{H1}	Fraction of semispan at horizontal tail tip (1.0)	USPAN, SPABM
116	η_{H2}	Fraction of semispan at horizontal tail span station 11 for weight analysis	USPAN, SPABM
.		To	
126	η_{H12}	Fraction of semispan at horizontal tail span station 1 for weight analysis	USPAN, SPABM
127	η_{H13}	Fraction of semispan at horizontal tail root station (0.0)	USPAN
128	US_{H1}	Shear at horizontal tail tip due to unit panel lift, lb/lb	USPAN, SPABM
.		To	
140	US_{H13}	Shear at horizontal tail root due to unit panel lift, lb/lb	USPAN, SPABM
141	UM_{XH1}	Moment at horizontal tail tip (swept) due to unit panel lift, in.-lb/lb	USPAN, SPABM
.		To	
153	UM_{XH13}	Moment at horizontal tail root (swept) due to unit panel lift, in.-lb/lb	USPAN, SPABM
154	UM_{YH1}	Torque at horizontal tail tip (swept) due to unit panel lift, in.-lb/lb	USPAN, SPABM
.		To	

TABLE 25. BU ARRAY VARIABLES (CONT)

Loc	Engrg Symbol	Description	Subroutine Reference
166	UM_{YH13}	Torque at horizontal tail root (swept) due to unit panel lift, in.-lb/lb	USPAN, SPABM
167	C_{YBV}	Vertical tail lift curve slope, per radian	USPAN, BNLDS
168	$K_{V(B)}$	Fraction of vertical tail load on exposed panel	USPAN
169	$\Delta\bar{Z}_V$	Z-distance to vertical tail load measured from root, in.	USPAN, BNLDS
170	$\Delta\bar{X}_V$	X-distance (from leading edge apex) to vertical tail load, in.	USPAN, BNLDS
171	$US_{V(SOB)}$	Shear at vertical tail-body interface due to unit surface load, lb/lb	USPAN, SPABM
172	$UM_{XV(SOB)}$	Moment at vertical tail-body interface (unswept) due to unit surface load, in.-lb/lb	USPAN, SPABM
173	$UM_{YV(SOB)}$	Torque at vertical tail-body interface (unswept) due to unit surface load, in.-lb/lb	USPAN, SPABM
174	η_{V1}	Fraction of span at vertical tail tip (1.0)	USPAN, SPABM
175	η_{V2}	Fraction of span at vertical tail span station 11 for weight analysis	USPAN, SPABM
.		To	
185	η_{V12}	Fraction of span at vertical tail span station 1 for weight analysis	USPAN, SPABM

TABLE 25. BU ARRAY VARIABLES (CONCL)

Loc	Engrg Symbol	Description	Subroutine Reference
186	η_{V13}	Fraction of span at vertical tail root station (0.0)	USPAN
187	US_{V1}	Shear at vertical tail tip, due to unit surface load, lb/lb	USPAN, SPABM
•		To	
199	US_{V13}	Shear at vertical tail root due to unit surface load, lb/lb	USPAN, SPABM
200	UM_{XV1}	Moment at vertical tail tip (swept) due to unit surface load, in.-lb/lb	USPAN, SPABM
•		To	
212	UM_{XV13}	Moment at vertical tail root (swept) due to unit surface load, in.-lb/lb	USPAN, SPABM
213	UM_{ZV1}	Torque at vertical tail tip (swept) due to unit surface load, in.-lb/lb	USPAN, SPABM
•		To	
225	UM_{ZV13}	Torque at vertical tail root (swept) due to unit surface load, in.-lb/lb	USPAN, SPABM
226	$P_{ZW(B)A}$	Wing lift in presence of body due to angle of attack, lb	BNLDS, SPABM
227	$P_{ZW(B)F}$	Wing lift in presence of body due to flap deflection, lb	BNLDS, SPABM
228	P_{ZH}	Horizontal tail lift normal to planform, lb	BNLDS, SPABM

NOTE BU array starts at common location 3153

TABLE 26. DB ARRAY, SUBSONIC AERODYNAMIC DATA

Loc	Value	Engrg Symbol	Description
1	0.0	ΛB_1	Compressible sweep parameter 1, deg
2	15.0	ΛB_2	Compressible sweep parameter 2, deg
3	30.0	ΛB_3	Compressible sweep parameter 3, deg
4	45.0	ΛB_4	Compressible sweep parameter 4, deg
5	60.0	ΛB_5	Compressible sweep parameter 5, deg
6	75.0	ΛB_6	Compressible sweep parameter 6, deg
7	1.5	BA/K_1	Aspect ratio parameter 1
8	2.5	BA/K_2	Aspect ratio parameter 2
9	3.5	BA/K_3	Aspect ratio parameter 3
10	4.5	BA/K_4	Aspect ratio parameter 4
11	6.0	BA/K_5	Aspect ratio parameter 5
12	8.0	BA/K_6	Aspect ratio parameter 6
13	10.0	BA/K_7	Aspect ratio parameter 7
14	1.355	$C_\ell C/C_L C_{AV}$	Spanwise loading parameter at BA/K_1, ΛB_1, η_1, λ_1
.	.	.	Refer to Table 27 for complete spanwise
.	.	.	loading parameter values.
685	1.270	$C_\ell C/C_L C_{AV}$	Spanwise loading parameter at A/K_7, ΛB_6, η_4, λ_4
686	0.0335	$BC_{L}\alpha/K$	Lift-curve slope parameter at BA/K_1, ΛB_1, λ_1, per degree
.	.	.	Refer to Table 28 for complete lift-curve
.	.	.	slope parameter values.
853	0.0240	$BC_{L}\alpha/K$	Lift-curve slope parameter at BA/ ΛB_6, λ_4, per degree

NOTE

1. DB array starts at common location 156.
2. The normalized spanwise stations (η) and the taper ratios referenced in this table are defined in the DT array. (Refer to Table 50,)
3. This arrary is stored in permanent data file record 2, read in BLCNTL, and used in USPAN

TABLE 27. SUBSONIC SPANWISE LOADING PARAMETER VARIABLES IN DB ARRAY

η	λ	BA/K	DB Array Loc Ind (I \ J)	$C_\ell C/C_L C_{AV}$ $\Lambda_B = 0°$	$\Lambda_B = 15°$	$\Lambda_B = 30°$	$\Lambda_B = 45°$	$\Lambda_B = 60°$	$\Lambda_B = 75°$
				0	1	2	3	4	5
0.0	0.0	1.5	14	1.355	1.340	1.325	1.310	1.300	1.295
0.0	0.0	2.5	20	1.405	1.380	1.352	1.322	1.310	1.298
0.0	0.0	3.5	26	1.450	1.405	1.372	1.340	1.312	1.301
0.0	0.0	4.5	32	1.480	1.430	1.387	1.350	1.314	1.304
0.0	0.0	6.0	38	1.520	1.457	1.400	1.355	1.316	1.306
0.0	0.0	8.0	44	1.580	1.493	1.420	1.360	1.318	1.308
0.0	0.0	10.0	50	1.610	1.520	1.435	1.370	1.320	1.310
0.0	0.25	1.5	56	1.307	1.300	1.286	1.265	1.232	1.140
0.0	0.25	2.5	62	1.332	1.302	1.278	1.240	1.175	1.070
0.0	0.25	3.5	68	1.346	1.305	1.267	1.215	1.135	1.020
0.0	0.25	4.5	74	1.360	1.307	1.260	1.200	1.100	1.000
0.0	0.25	6.0	80	1.382	1.310	1.250	1.180	1.080	0.970
0.0	0.25	8.0	86	1.400	1.312	1.232	1.140	1.045	0.940
0.0	0.25	10.0	92	1.420	1.315	1.220	1.120	1.005	0.880
0.0	0.50	1.5	98	1.290	1.280	1.265	1.242	1.183	1.035
0.0	0.50	2.5	104	1.291	1.270	1.240	1.185	1.100	0.945
0.0	0.50	3.5	110	1.292	1.255	1.200	1.140	1.030	0.860
0.0	0.50	4.5	116	1.293	1.240	1.180	1.100	0.970	0.785
0.0	0.50	6.0	122	1.296	1.230	1.150	1.050	0.915	0.710
0.0	0.50	8.0	128	1.300	1.210	1.120	1.010	0.860	0.605
0.0	0.50	10.0	134	1.305	1.200	1.090	0.950	0.770	0.520

NOTE I+J = DB array relative location.

TABLE 27. SUBSONIC SPANWISE LOADING PARAMETER VARIABLES IN DB ARRAY (CONT)

			DB Array Loc Ind	$C_\ell C/C_L C_{AV}$					
				$\Lambda_B = 0°$	$\Lambda_B = 15°$	$\Lambda_B = 30°$	$\Lambda_B = 45°$	$\Lambda_B = 60°$	$\Lambda_B = 75°$
η	λ	BA/K	I \ J	0	1	2	3	4	5
0.0	1.00	1.5	140	1.267	1.252	1.225	1.190	1.090	0.890
0.0	1.00	2.5	146	1.250	1.212	1.163	1.090	0.960	0.750
0.0	1.00	3.5	152	1.235	1.150	1.107	1.010	0.880	0.700
0.0	1.00	4.5	158	1.215	1.145	1.060	0.945	0.805	0.610
0.0	1.00	6.0	164	1.185	1.100	1.002	0.885	0.740	0.550
0.0	1.00	8.0	170	1.167	1.067	0.945	0.810	0.660	0.460
0.0	1.00	10.0	176	1.140	1.025	0.892	0.745	0.575	0.350
0.383	0.0	1.5	182	1.220	1.207	1.200	1.200	1.201	1.210
0.383	0.0	2.5	188	1.235	1.220	1.212	1.212	1.215	1.230
0.383	0.0	3.5	194	1.240	1.227	1.221	1.225	1.230	1.245
0.383	0.0	4.5	200	1.250	1.240	1.232	1.230	1.245	1.260
0.383	0.0	6.0	206	1.260	1.257	1.250	1.245	1.250	1.270
0.383	0.0	8.0	212	1.270	1.270	1.273	1.275	1.290	1.300
0.383	0.0	10.0	218	1.265	1.265	1.265	1.270	1.280	1.295
0.383	0.25	1.5	224	1.185	1.180	1.180	1.180	1.175	1.150
0.383	0.25	2.5	230	1.185	1.180	1.180	1.180	1.175	1.150
0.383	0.25	3.5	236	1.184	1.180	1.180	1.170	1.166	1.135
0.383	0.25	4.5	242	1.183	1.180	1.180	1.170	1.166	1.135
0.383	0.25	6.0	248	1.182	1.180	1.180	1.165	1.155	1.120

NOTE I+J = DB array relative location.

TABLE 27. SUBSONIC SPANWISE LOADING PARAMETER VARIABLES IN DB ARRAY (CONT)

			DB Array Loc Ind	$C_\ell C/C_L C_{AV}$					
				$\Lambda_B = 0°$	$\Lambda_B = 15°$	$\Lambda_B = 30°$	$\Lambda_B = 45°$	$\Lambda_B = 60°$	$\Lambda_B = 75°$
η	λ	BA/K	I \ J	0	1	2	3	4	5
0.383	0.25	8.0	254	1.181	1.180	1.180	1.165	1.155	1.120
0.383	0.25	10.0	260	1.177	1.176	1.175	1.160	1.150	1.100
0.383	0.50	1.5	266	1.180	1.180	1.180	1.175	1.165	1.140
0.383	0.50	2.5	272	1.180	1.180	1.175	1.162	1.150	1.112
0.383	0.50	3.5	278	1.180	1.170	1.165	1.150	1.140	1.090
0.383	0.50	4.5	284	1.170	1.165	1.160	1.145	1.120	1.080
0.383	0.50	6.0	290	1.160	1.160	1.155	1.132	1.110	1.055
0.383	0.50	8.0	296	1.155	1.155	1.150	1.120	1.090	1.035
0.383	0.50	10.0	302	1.145	1.140	1.130	1.105	1.070	1.005
0.383	1.00	1.5	308	1.175	1.170	1.170	1.680	1.160	1.135
0.383	1.00	2.5	314	1.170	1.165	1.162	1.155	1.135	1.070
0.383	1.00	3.5	320	1.165	1.160	1.155	1.142	1.110	1.020
0.383	1.00	4.5	326	1.152	1.150	1.145	1.122	1.080	0.970
0.383	1.00	6.0	332	1.140	1.140	1.130	1.105	1.045	0.920
0.383	1.00	8.0	338	1.120	1.120	1.117	1.080	1.010	0.890
0.383	1.00	10.0	344	1.112	1.112	1.098	1.060	0.980	0.845

NOTE I+J = DB array relative location.

TABLE 27. SUBSONIC SPANWISE LOADING PARAMETER VARIABLES IN DB ARRAY (CONT)

			DB Array Loc Ind	$C_\ell C/C_L C_{AV}$					
				$\Lambda_B = 0°$	$\Lambda_B = 15°$	$\Lambda_B = 30°$	$\Lambda_B = 45°$	$\Lambda_B = 60°$	$\Lambda_B = 75°$
η	λ	BA/K	I \ J	0	1	2	3	4	5
0.707	0.0	1.5	350	0.855	0.862	0.870	0.870	0.870	0.875
0.707	0.0	2.5	356	0.825	0.842	0.850	0.860	0.868	0.874
0.707	0.0	3.5	362	0.800	0.825	0.840	0.860	0.865	0.872
0.707	0.0	4.5	368	0.780	0.805	0.830	0.850	0.860	0.870
0.707	0.0	6.0	374	0.750	0.785	0.810	0.840	0.858	0.868
0.707	0.0	8.0	380	0.720	0.766	0.800	0.830	0.855	0.867
0.707	0.0	10.0	386	0.700	0.740	0.775	0.810	0.842	0.865
0.707	0.25	1.5	392	0.880	0.890	0.900	0.915	0.935	0.970
0.707	0.25	2.5	398	0.875	0.887	0.903	0.920	0.950	0.998
0.707	0.25	3.5	404	0.860	0.884	0.907	0.927	0.960	1.010
0.707	0.25	4.5	410	0.850	0.880	0.910	0.940	0.990	1.045
0.707	0.25	6.0	416	0.840	0.876	0.913	0.950	1.000	1.070
0.707	0.25	8.0	422	0.830	0.873	0.917	0.960	1.015	1.090
0.707	0.25	10.0	428	0.815	0.870	0.920	0.970	1.030	1.100
0.707	0.50	1.5	434	0.890	0.900	0.905	0.920	0.955	1.030
0.707	0.50	2.5	440	0.890	0.900	0.922	0.955	1.005	1.085
0.707	0.50	3.5	446	0.890	0.[illegible]0	0.940	0.980	1.003	1.110
0.707	0.50	4.5	452	0.890	0.920	0.955	0.995	1.055	1.150

NOTE I+J = DB array relative location.

TABLE 27. SUBSONIC SPANWISE LOADING PARAMETER VARIABLES IN DB ARRAY (CONT)

			DB Array Loc Ind	$C_\ell C/C_L C_{AV}$					
				$\Lambda_B = 0°$	$\Lambda_B = 15°$	$\Lambda_B = 30°$	$\Lambda_B = 45°$	$\Lambda_B = 60°$	$\Lambda_B = 75°$
η	λ	BA/K	I \ J	0	1	2	3	4	5
0.707	0.50	6.0	458	0.890	0.930	0.970	1.015	1.085	1.185
0.707	0.50	8.0	464	0.890	0.935	0.985	1.040	1.110	1.230
0.707	0.50	10.0	470	0.890	0.945	1.000	1.070	1.155	1.260
0.707	1.00	1.5	476	0.910	0.910	0.920	0.950	1.000	1.130
0.707	1.00	2.5	482	0.920	0.940	0.970	1.010	1.090	1.215
0.707	1.00	3.5	488	0.935	0.960	0.995	1.055	1.130	1.250
0.707	1.00	4.5	494	0.947	0.985	1.030	1.090	1.165	1.285
0.707	1.00	6.0	500	0.960	1.005	1.060	1.120	1.200	1.310
0.707	1.00	8.0	506	0.980	1.030	1.090	1.160	1.250	1.350
0.707	1.00	10.0	512	0.990	1.050	1.115	1.195	1.290	1.400
0.924	0.0	1.5	518	0.390	0.415	0.420	0.438	0.445	0.420
0.924	0.0	2.5	524	0.340	0.367	0.390	0.402	0.410	0.400
0.924	0.0	3.5	530	0.305	0.340	0.367	0.382	0.395	0.390
0.924	0.0	4.5	536	0.285	0.318	0.347	0.365	0.380	0.380
0.924	0.0	6.0	542	0.252	0.290	0.320	0.350	0.362	0.360
0.924	0.0	8.0	548	0.200	0.245	0.288	0.312	0.340	0.340
0.924	0.0	10.0	554	0.207	0.250	0.292	0.316	0.342	0.350
0.924	0.25	1.5	560	0.465	0.480	0.485	0.495	0.515	0.600
0.924	0.25	2.5	566	0.464	0.483	0.495	0.520	0.570	0.660

NOTE I+J = DB array relative location.

TABLE 27. SUBSONIC SPANWISE LOADING PARAMETER VARIABLES IN DB ARRAY (CONCL)

			DB Array Loc Ind	$C_\ell C/C_L C_{AV}$					
				$\Lambda_B = 0°$	$\Lambda_B = 15°$	$\Lambda_B = 30°$	$\Lambda_B = 45°$	$\Lambda_B = 60°$	$\Lambda_B = 75°$
η	λ	BA/K	I \ J	0	1	2	3	4	5
0.924	0.25	3.5	572	0.462	0.485	0.500	0.540	0.605	0.730
0.924	0.25	4.5	578	0.460	0.488	0.510	0.560	0.630	0.750
0.924	0.25	6.0	584	0.462	0.490	0.530	0.590	0.675	0.800
0.924	0.25	8.0	590	0.464	0.500	0.550	0.625	0.730	0.885
0.924	0.25	10.0	596	0.465	0.510	0.565	0.640	0.760	0.935
0.924	0.50	1.5	602	0.485	0.490	0.495	0.502	0.535	0.650
0.924	0.50	2.5	608	0.485	0.492	0.510	0.550	0.605	0.710
0.924	0.50	3.5	614	0.490	0.510	0.545	0.592	0.675	0.820
0.924	0.50	4.5	620	0.500	0.530	0.570	0.620	0.710	0.870
0.924	0.50	6.0	626	0.515	0.550	0.600	0.665	0.760	0.910
0.924	0.50	8.0	632	0.537	0.580	0.640	0.710	0.815	0.960
0.924	0.50	10.0	638	0.550	0.610	0.680	0.760	0.870	1.020
0.924	1.00	1.5	644	0.500	0.500	0.510	0.530	0.570	0.700
0.924	1.00	2.5	650	0.510	0.520	0.550	0.590	0.660	0.855
0.924	1.00	3.5	656	0.525	0.553	0.590	0.645	0.745	0.940
0.924	1.00	4.5	662	0.550	0.580	0.625	0.690	0.800	0.990
0.924	1.00	6.0	668	0.580	0.620	0.680	0.755	0.875	1.070
0.924	1.00	8.0	674	0.610	0.665	0.730	0.825	0.960	1.160
0.924	1.00	10.0	680	0.642	0.700	0.780	0.885	1.030	1.270

NOTE I+J = DB array relative location.

TABLE 28. SUBSONIC LIFT CURVE SLOPE PARAMETER VARIABLES IN DB ARRAY

		DB Array Loc Ind	$BC_{L\alpha}/K$, per degree					
			$\Lambda_B = 0°$	$\Lambda_B = 15°$	$\Lambda_B = 30°$	$\Lambda_B = 45°$	$\Lambda_B = 60°$	$\Lambda_B = 75°$
λ	BA/K	I \ J	0	1	2	3	4	5
0.0	1.5	686	0.0335	0.0342	0.0348	0.0348	0.0315	0.0225
0.0	2.5	692	0.0473	0.0484	0.0482	0.0462	0.0395	0.0231
0.0	3.5	698	0.0574	0.0584	0.0572	0.0525	0.0425	0.0237
0.0	4.5	704	0.0643	0.0650	0.0628	0.0569	0.0453	0.0244
0.0	6.0	710	0.0720	0.0727	0.0694	0.0615	0.0475	0.0265
0.0	8.0	716	0.0787	0.0788	0.0745	0.0645	0.0493	0.0272
0.0	10.0	722	0.0847	0.0840	0.0780	0.0670	0.0505	0.0278
0.25	1.5	728	0.0348	0.0350	0.0350	0.0350	0.0315	0.0205
0.25	2.5	734	0.0498	0.0500	0.0492	0.0465	0.0380	0.0217
0.25	3.5	740	0.0600	0.0605	0.0585	0.0527	0.0420	0.0229
0.25	4.5	746	0.0676	0.0673	0.0638	0.0568	0.0439	0.0242
0.25	6.0	752	0.0760	0.0750	0.0702	0.0610	0.0465	0.0260
0.25	8.0	758	0.0828	0.0810	0.0750	0.0647	0.0490	0.0268
0.25	10.0	764	0.0880	0.0860	0.0796	0.0677	0.0505	0.0275
0.50	1.5	770	0.0350	0.0350	0.0348	0.0338	0.0300	0.0200
0.50	2.5	776	0.0500	0.0500	0.0484	0.0450	0.0370	0.0209
0.50	3.5	782	0.0600	0.0598	0.0570	0.0510	0.0400	0.0219
0.50	4.5	788	0.0679	0.0669	0.0628	0.0546	0.0418	0.0228
0.50	6.0	794	0.0760	0.0740	0.0680	0.0585	0.0440	0.0236

NOTE I+J = DB array relative location.

TABLE 28. SUBSONIC LIFT CURVE SLOPE PARAMETER VARIABLES IN DB ARRAY (CONCL)

			$BC_{L\alpha}/K$, per degree					
		DB Array Loc Ind	$\Lambda_B = 0°$	$\Lambda_B = 15°$	$\Lambda_B = 30°$	$\Lambda_B = 45°$	$\Lambda_B = 60°$	$\Lambda_B = 75°$
λ	BA/K	I \ J	0	1	2	3	4	5
0.50	8.0	800	0.0830	0.0800	0.0725	0.0615	0.0450	0.0242
0.50	10.0	806	0.0878	0.0845	0.0755	0.0630	0.0460	0.0248
1.00	1.5	812	0.0347	0.0346	0.0340	0.0322	0.0280	0.0185
1.00	2.5	818	0.0485	0.0480	0.0458	0.0415	0.0340	0.0192
1.00	3.5	824	0.0582	0.0568	0.0535	0.0475	0.0370	0.0198
1.00	4.5	830	0.0650	0.0630	0.0584	0.0505	0.0385	0.0205
1.00	6.0	836	0.0730	0.0702	0.0645	0.0545	0.0405	0.0215
1.00	8.0	842	0.0795	0.0760	0.0685	0.0575	0.0425	0.0228
1.00	10.0	848	0.0840	0.0805	0.0732	0.0615	0.0450	0.0240

NOTE I+J = DB array relative location.

TABLE 29. DE ARRAY, MANEUVER LOAD FACTOR SPECTRA TABLES

Loc	Description
1 . 100	Maneuver load factor spectra for fighter or attack class. Refer to Table 30 for file data values.
101 . 140	Maneuver load factor spectra for BI class. Refer to Table 31 for the file data values.
141 . 220	Maneuver load factor spectra for BII class. Refer to Table 32 for file data values.
221 . 280	Maneuver load factor spectra for cargo-assault class. Refer to Table 33 for file data values.
281 . 340	Maneuver load factor spectra for cargo-transport class. Refer to Table 34 for file data values.

NOTE

1. DE array starts at common location 2177.
2. This array is stored in permanent data file record 6, which is read and used in FATMG.

TABLE 30. MANEUVER LOAD FACTOR SPECTRA FOR FIGHTER OR ATTACK CLASSES IN DE ARRAY

DE Array Location Indicator	Load Factor (n_z)	Exceedences per 1,000 Hours by Mission Segment			
		Ascent, Cruise, Loiter, or Descent Type 1	Air-to Ground Combat Type 2	Subsonic Air-to-Air Combat Type 3	Supersonic Air-to-Air Combat Type 4
J \ I	0	20	40	60	80
1	10.0	0	0	15	0
2	9.0	0	1	60	0
3	8.0	0	15	230	16
4	7.0	0.04	200	900	90
5	6.0	1.0	1,500	3,400	500
6	5.0	25	10,000	13,000	2,900
7	4.0	400	40,000	50,000	17,000
8	3.0	3,500	100,000	150,000	90,000
9	2.0	15,000	175,000	300,000	250,000
10	1.5	24,000	210,000	390,000	320,000
11	0.5	0.0	10,000	44,000	16,000
12	0.0	0.0	350	4,000	2,000
13	-1.0	0.0	7	350	45
14	-2.0	0.0	1	8	0.1
15	-3.0	0.0	0	0.1	0
16	-4.0	0.0	0	0	0
17	-5.0	0.0	0	0	0
18	-6.0	0.0	0	0	0
19	-7.0	0.0	0	0	0
20	-8.0	0.0	0	0	0

NOTE I + J = DE array relative location

TABLE 31. MANEUVER LOAD FACTOR SPECTRUM FOR BI CLASS, ALL SEGMENTS, IN DE ARRAY

DE Array Location Indicator	Load Factor (n_z)	Exceedences per 1,000 Hours
J \ I	100	120
1	6.0	0
2	5.5	0.5
3	5.0	3
4	4.5	18
5	4.0	70
6	3.5	250
7	3.0	800
8	2.5	2,500
9	2.0	9,200
10	1.5	31,000
11	0.5	1,000
12	0.0	350
13	-0.5	1
14	-1.0	0
15	-1.5	0
16	-2.0	0
17	-2.5	0
18	-3.0	0
19	-3.5	0
20	-4.0	0

NOTE I + J = DE array relative location

TABLE 32. MANEUVER LOAD FACTOR SPECTRA FOR BII CLASS IN DE ARRAY

DE Array Location Indicator	Load Factor (n_z)	Exceedences per 1,000 Hours by Segment: Ascent, Descent, or Refueling Type 1	Cruise or High-Altitude Penetration Type 2	Low-Altitude Penetration Type 3
J \ I	140	160	180	200
1	3.8	0	0	0
2	3.5	0	0	0
3	3.2	0.01	0	0.02
4	2.9	0.06	0.003	0.12
5	2.6	0.3	0.03	0.6
6	2.3	2	0.40	4
7	2.0	15	4	30
8	1.7	300	60	600
9	1.4	7,200	1,300	14,400
10	1.1	150,000	35,000	300,000
11	0.9	85,000	20,000	300,000
12	0.6	3,900	240	14,400
13	0.3	86	4	600
14	0.0	7	0.1	30
15	-0.3	0.9	0.002	4
16	-0.6	0.1	0	0.6
17	-0.9	0.01	0	0.12
18	-1.2	0	0	0.02
19	-1.5	0	0	0
20	-1.8	0	0	0

NOTE I + J = DE array relative location

TABLE 33. MANEUVER LOAD FACTOR SPECTRA FOR CARGO ASSAULT CLASS IN DE ARRAY

DE Array Location Indicator	Load Factor (n_z)	Exceedences per 1,000 Hours by Segment	
		Ascent or Descent Type 1	Cruise Type 2
I / J	220	240	260
1	3.8	0	0
2	3.5	0.05	0.02
3	3.2	0.12	0.05
4	2.9	0.25	0.11
5	2.6	0.50	0.25
6	2.3	1.8	0.54
7	2.0	10	2
8	1.7	130	16
9	1.4	1,500	300
10	1.1	100,000	10,000
11	0.9	30,000	5,000
12	0.6	100	30
13	0.3	0.5	1
14	0.0	0.002	0.03
15	-0.3	0	0.001
16	-0.6	0	0
17	-0.9	0	0
18	-1.2	0	0
19	-1.5	0	0
20	-1.8	0	0

NOTE I + J = DE array relative location

TABLE 34. MANEUVER LOAD FACTOR SPECTRA FOR CARGO TRANSPORT CLASS IN DE ARRAY

DE Array Location Indicator	Load Factor (n_z)	Exceedences per 1,000 Hours by Segment	
		Ascent, Descent, or Refuelings	Cruise
J \ I	280	300	320
1	3.8	0	0
2	3.5	0	0
3	3.2	0.03	0
4	2.9	0.17	0
5	2.6	0.90	0.003
6	2.3	4	0.05
7	2.0	19	1
8	1.7	105	25
9	1.4	1,470	825
10	1.1	70,000	30,000
11	0.9	8,000	1,920
12	0.6	136	22
13	0.3	0.30	0.15
14	0.0	0.001	0.001
15	-0.3	0	0
16	-0.6	0	0
17	-0.9	0	0
18	-1.2	0	0
19	-1.5	0	0
20	-1.8	0	0

NOTE I + J = DE array relative location

TABLE 35. DF ARRAY, FLAP AERODYNAMIC DATA

Loc	Value	Engrg Symbol	Description
1	0.0	CF/CW_1	Flap chord ratio 1
2	0.10	CF/CW_2	Flap chord ratio 2
3	0.30	CF/CW_3	Flap chord ratio 3
4	0.65	CF/CW_4	Flap chord ratio 4
5	1.00	CF/CW_5	Flap chord ratio 5
6	0.575	X/C_1	Local CP for CF/CW_1
7	0.520	X/C_2	Local CP for CF/CW_2
8	0.450	X/C_3	Local CP for CF/CW_3
9	0.373	X/C_4	Local CP for CF/CW_4
10	0.333	X/C_5	Local CP for CF/CW_5
11	0.0	KCF_1	Flap lift effectiveness for CF/CW_1
12	0.390	KCF_2	Flap lift effectiveness for CF/CW_2
13	0.655	KCF_3	Flap lift effectiveness for CF/CW_3
14	0.902	KCF_4	Flap lift effectiveness for CF/CW_4
15	1.000	KCF_5	Flap lift effectiveness for CF/CW_5
16	0.10	bf/bw_1	Flap span ratio 1
17	0.20	bf/bw_2	Flap span ratio 2
18	0.30	bf/bw_3	Flap span ratio 3
19	0.40	bf/bw_4	Flap span ratio 4
20	0.50	bf/bw_5	Flap span ratio 5

TABLE 35. DF ARRAY, FLAP AERODYNAMIC DATA (CONCL)

Loc	Value	Engrg Symbol	Description
21	0.60	bf/bw_6	Flap span ratio 6
22	0.70	bf/bw_7	Flap span ratio 7
23	0.80	bf/bw_8	Flap span ratio 8
24	0.90	bf/bw_9	Flap span ratio 9
25	1.00	bf/bw_{10}	Flap span ratio 10
26	0.00	η_1	Normalized spanwise station 1
27	0.10	η_2	Normalized spanwise station 2
28	0.20	η_3	Normalized spanwise station 3
29	0.30	η_4	Normalized spanwise station 4
30	0.40	η_5	Normalized spanwise station 5
31	0.50	η_6	Normalized spanwise station 6
32	0.60	η_7	Normalized spanwise station 7
33	0.70	η_8	Normalized spanwise station 8
34	0.80	η_9	Normalized spanwise station 9
35	0.90	η_{10}	Normalized spanwise station 10
36	1.00	η_{11}	Normalized spanwise station 11
37	0.520	$C_\ell C/C_L C_{AV}$	Spanwise loading parameter at bf/bw_1, η_1.
.	.		Refer to Table 36 for complete spanwise
.	.		loading parameter values.
146	0.0	$C_\ell C/C_L C_{AV}$	Spanwise loading parameter at bf/bw_{10}, η_{11}

NOTE

1. DF array starts at common location 1009.
2. This array is stored in mass storage file record 3, read in BLCNTL, and used in USPAN and BNLDS.

TABLE 36. FLAP INCREMENTAL SPANWISE LOADING PARAMETER VARIABLES IN DF ARRAY

η	DF Array Location Indicator	$C_\ell C/C_{L\alpha}C_{AV}$									
		F=0.1	F=0.2	F=0.3	F=0.4	F=0.5	F=0.6	F=0.7	F=0.8	F=0.9	F=1.0
	J \ I	37	48	59	70	81	92	103	114	125	136
0.0	0	0.520	0.788	0.964	1.068	1.120	1.170	1.232	1.240	1.250	1.240
0.1	1	0.410	0.776	0.970	1.052	1.124	1.176	1.230	1.240	1.250	1.240
0.2	2	0.216	0.540	0.930	1.008	1.108	1.170	1.200	1.220	1.240	1.220
0.3	3	0.164	0.336	0.680	0.920	1.040	1.116	1.115	1.118	1.220	1.208
0.4	4	0.120	0.252	0.424	0.604	0.948	1.028	1.088	1.120	1.170	1.172
0.5	5	0.084	0.196	0.308	0.400	0.640	0.912	0.990	1.050	1.080	1.092
0.6	6	0.052	0.140	0.220	0.304	0.430	0.586	0.852	0.940	0.980	1.000
0.7	7	0.040	0.100	0.160	0.212	0.300	0.396	0.600	0.800	0.864	0.900
0.8	8	0.040	0.072	0.110	0.150	0.200	0.268	0.350	0.540	0.736	0.768
0.9	9	0.032	0.052	0.072	0.096	0.120	0.160	0.200	0.280	0.460	0.588
1.0	10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

NOTE $F = b_F/b_W$

I + J = DF array relative location

TABLE 37. DG ARRAY, TURBULENCE FIELD PARAMETERS

DG Array Location Indicator	Altitude (ft)	P1	B1 (ft/sec)	P2	B2 (ft/sec)	L (ft)
J \ I	0	12	24	36	48	60
1	0	1.00000	2.70	0.000010	10.65	500
2	250	1.00000	2.70	0.000010	10.65	500
3	1,000	1.00000	2.70	0.000010	10.65	500
4	1,750	0.42000	3.02	0.003300	5.94	1,750
5	3,750	0.30000	3.42	0.002000	8.17	2,500
6	7,500	0.15000	3.59	0.000950	9.22	2,500
7	15,000	0.06200	3.27	0.000280	10.52	2,500
8	25,000	0.02500	3.15	0.000110	11.88	2,500
9	35,000	0.01100	2.93	0.000095	9.84	2,500
10	45,000	0.00460	3.28	0.000115	8.81	2,500
11	55,000	0.00200	3.82	0.000078	7.04	2,500
12	65,000	0.00088	2.93	0.000057	4.33	2,500

NOTES

1. I + J = DG array relative location.
2. DG array starts at common location 2577.
3. This array is stored in permanent data file record 8 which is read and used in FATMG.

TABLE 38. DI ARRAY, TAXI LOAD FACTOR SPECTRA

DI Array Location Indicator	Load Factor (n_z)	Exceedences per 1,000 Landings	
		F, A, or BI Class	BII, Cargo-Assault, or Cargo-Transport Class
J \ I	0	20	40
1	1.9	0.00004	0.00008
2	1.85	0.0002	0.0004
3	1.8	0.001	0.002
4	1.7	0.03	0.06
5	1.6	0.9	1.8
6	1.5	20	40
7	1.4	450	900
8	1.3	9,000	18,000
9	1.2	86,000	172,000
10	1.1	330,000	660,000
11	0.9	330,000	660,000
12	0.8	86,000	172,000
13	0.7	9,000	18,000
14	0.6	450	900
15	0.5	20	40
16	0.4	0.9	1.8
17	0.3	0.03	0.06
18	0.2	0.001	0.002
19	0.15	0.0002	0.0004
20	0.1	0.00004	0.00008

NOTES
1. I + J = DI array relative location.
2. DI array starts at common location 2517.
3. This array is stored in permanent data file record 7 which is read and used in FATMG.

TABLE 39. DP ARRAY, SUPERSONIC AERODYNAMIC DATA

Loc	Value	Engrg Symbol	Description
1	2.0	BA_1	Aspect-ratio parameter 1
2	3.0	BA_2	Aspect-ratio parameter 2
3	4.0	BA_3	Aspect-ratio parameter 3
4	6.0	BA_4	Aspect-ratio parameter 4
5	12.0	BA_5	Aspect-ratio parameter 5
6	0.4	Bm_1	Sweep parameter 1
7	0.6	Bm_2	Sweep parameter 2
8	0.8	Bm_3	Sweep parameter 3
9	1.0	Bm_4	Sweep parameter 4
10	1.3	Bm_5	Sweep parameter 5
11	2.0	Bm_6	Sweep parameter 6
12	3.0	Bm_7	Sweep parameter 7
13	5.0	Bm_8	Sweep parameter 8
14	12.0	Bm_9	Sweep parameter 9
15	1.392	$2\ \Gamma/V\alpha b$	Spanwise loading parameter at BA_1, Bm_1, η_1, λ_1
.	.	.	Refer to Table 40 for complete spanwise
.	.	.	loading parameter values.
734	0.270	$2\ \Gamma/V\alpha b$	Spanwise loading parameter at BA_5, Bm_9, η_4, λ_4

NOTE

1. DP array starts at common location 1155.

2. The normalized spanwise stations (η) and the taper ratios referenced in this table are defined in the DT array. (Refer to Table 50.)

3. This array is stored in permanent data file record 4, read in BLCNTL, and used in USPAN.

TABLE 40. SUPERSONIC SPANWISE LOADING PARAMETER VARIABLES IN DP ARRAY

			DP Array Loc Ind	$2\Gamma/Vab$								
				Bm=0.4	Bm=0.6	Bm=0.8	Bm=1.0	Bm=1.3	Bm=2.0	Bm=3.0	Bm=5.0	Bm=12.0
η	λ	BA	I \ J	0	1	2	3	4	5	6	7	8
0.0	0.0	2.0	15	1.392	1.880	2.256	2.536	2.700	3.050	3.325	3.475	3.675
0.0	0.0	3.0	24	0.915	1.260	1.500	1.700	1.842	2.056	2.260	2.375	2.520
0.0	0.0	4.0	33	0.708	0.940	1.130	1.275	1.388	1.536	1.670	1.776	1.900
0.0	0.0	6.0	42	0.455	0.626	0.758	0.850	0.923	1.026	1.105	1.190	1.270
0.0	0.0	12.0	51	0.224	0.310	0.378	0.425	0.462	0.515	0.550	0.592	0.633
0.0	0.25	2.0	60	1.100	1.510	1.810	2.040	2.155	2.295	2.435	2.605	2.760
0.0	0.25	3.0	69	0.753	1.004	1.200	1.352	1.480	1.650	1.776	1.900	2.020
0.0	0.25	4.0	78	0.545	0.746	0.902	1.020	1.105	1.235	1.330	1.420	1.515
0.0	0.25	6.0	87	0.353	0.490	0.600	0.680	0.738	0.825	0.888	0.948	1.008
0.0	0.25	12.0	96	0.190	0.260	0.310	0.338	0.370	0.410	0.443	0.475	0.510
0.0	0.50	2.0	105	0.910	1.256	1.510	1.700	1.800	1.910	2.050	2.170	2.330
0.0	0.50	3.0	114	0.603	0.828	1.005	1.134	1.224	1.372	1.476	1.580	1.685
0.0	0.50	4.0	123	0.462	0.635	0.755	0.850	0.920	1.025	1.110	1.188	1.260
0.0	0.50	6.0	132	0.296	0.410	0.503	0.568	0.615	0.686	0.740	0.792	0.840
0.0	0.50	12.0	141	0.138	0-200	0.255	0.282	0.308	0.343	0.368	0.395	0.420
0.0	1.00	2.0	150	0.732	0.975	1.150	1.272	1.384	1.540	1.660	1.776	1.895
0.0	1.00	3.0	159	0.448	0.620	0.752	0.850	0.930	1.030	1.111	1.199	1.255
0.0	1.00	4.0	168	0.338	0.468	0.570	0.640	0.690	0.770	0.835	0.890	0.935

NOTE I+J = DP array relative location

TABLE 40. SUPERSONIC SPANWISE LOADING PARAMETER VARIABLES IN DP ARRAY (CONT)

			DP Array Loc Ind	$2\Gamma/V\alpha b$								
				Bm=0.4	Bm=0.6	Bm=0.8	Bm=1.0	Bm=1.3	Bm=2.0	Bm=3.0	Bm=5.0	Bm=12.0
η	λ	BA	I \ J	0	1	2	3	4	5	6	7	8
0.0	1.00	6.0	177	0.213	0.302	0.373	0.425	0.460	0.514	0.556	0.595	0.630
0.0	1.00	12.0	186	0.100	0.148	0.188	0.212	0.230	0.258	0.278	0.299	0.312
0.383	0.0	2.0	195	1.376	1.656	1.852	2.000	2.000	2.000	2.000	2.075	2.125
0.383	0.0	3.0	204	1.015	1.240	1.360	1.450	1.470	1.510	1.510	1.560	1.575
0.383	0.0	4.0	213	0.860	1.015	1.114	1.117	1.168	1.198	1.200	1.216	1.229
0.383	0.0	6.0	222	0.660	0.782	0.846	0.836	0.868	0.850	0.832	0.826	0.824
0.383	0.0	12.0	231	0.440	0.520	0.552	0.570	0.526	0.472	0.443	0.420	0.416
0.383	0.25	2.0	240	1.270	1.564	1.745	1.880	2.000	2.107	2.180	2.220	2.260
0.383	0.25	3.0	249	0.980	1.172	1.290	1.370	1.390	1.420	1.440	1.480	1.490
0.383	0.25	4.0	258	0.795	0.960	1.054	1.114	1.110	1.112	1.114	1.124	1.122
0.383	0.25	6.0	267	0.575	0.720	0.805	0.840	0.820	0.792	0.775	0.765	0.760
0.383	0.25	12.0	276	0.355	0.460	0.520	0.542	0.498	0.438	0.403	0.390	0.380
0.383	0.50	2.0	285	1.240	1.500	1.670	1.796	1.801	1.812	1.828	1.860	1.900
0.383	0.50	3.0	294	0.915	1.110	1.236	1.314	1.328	1.344	1.372	1.388	1.400
0.383	0.50	4.0	303	0.750	0.915	1.015	1.070	1.060	1.060	1.061	1.062	1.076
0.383	0.50	6.0	312	0.542	0.690	0.780	0.810	0.784	0.755	0.740	0.728	0.719
0.383	0.50	12.0	321	0.340	0.445	0.511	0.526	0.478	0.415	0.380	0.365	0.360
0.383	1.00	2.0	330	1.145	1.405	1.580	1.692	1.740	1.774	1.778	1.776	1.772
0.383	1.00	3.0	339	0.825	1.030	1.170	1.248	1.250	1.263	1.280	1.296	1.310

NOTE I+J = DP array relative location

TABLE 40. SUPERSONIC SPANWISE LOADING PARAMETER VARIABLES IN DP ARRAY (CONT)

			DP Array Loc Ind	$2\Gamma/V\alpha b$								
				Bm=0.4	Bm=0.6	Bm=0.8	Bm=1.0	Bm=1.3	Bm=2.0	Bm=3.0	Bm=5.0	Bm=12.0
η	λ	BA	I \ J	0	1	2	3	4	5	6	7	8
0.383	1.00	4.0	348	0.665	0.845	0.960	1.016	1.005	0.998	0.996	0.995	0.995
0.383	1.00	6.0	357	0.500	0.640	0.730	0.770	0.744	0.712	0.692	0.680	0.670
0.383	1.00	12.0	366	0.320	0.430	0.482	0.505	0.454	0.385	0.353	0.342	0.335
0.707	0.0	2.0	375	1.080	1.240	1.320	1.380	1.250	1.140	1.070	1.020	1.010
0.707	0.0	3.0	384	0.835	0.980	1.032	1.072	0.990	0.892	0.820	0.770	0.765
0.707	0.0	4.0	393	0.713	0.826	0.876	0.900	0.800	0.700	0.614	0.590	0.588
0.707	0.0	6.0	402	0.550	0.662	0.700	0.715	0.592	0.450	0.410	0.392	0.388
0.707	0.0	12.0	411	0.330	0.430	0.482	0.490	0.305	0.225	0.202	0.198	0.194
0.707	0.25	2.0	420	1.240	1.440	1.448	1.443	1.395	1.325	1.245	1.160	1.065
0.707	0.25	3.0	429	0.965	1.126	1.202	1.250	1.180	1.080	1.010	0.940	0.890
0.707	0.25	4.0	438	0.783	0.943	1.012	1.045	0.965	0.860	0.796	0.756	0.735
0.707	0.25	6.0	447	0.586	0.735	0.804	0.820	0.725	0.580	0.530	0.508	0.505
0.707	0.25	12.0	456	0.355	0.470	0.540	0.560	0.390	0.287	0.264	0.255	0.252
0.707	0.05	2.0	465	1.380	1.448	1.479	1.470	1.400	1.320	1.245	1.160	1.110
0.707	0.50	3.0	474	1.010	1.210	1.308	1.364	1.268	1.180	1.100	1.028	0.970
0.707	0.50	4.0	483	0.800	0.995	1.100	1.135	1.060	0.975	0.902	0.850	0.807
0.707	0.50	6.0	492	0.585	0.760	0.860	0.890	0.796	0.664	0.608	0.585	0.578
0.707	0.50	12.0	501	0.400	0.512	0.580	0.602	0.450	0.330	0.302	0.292	0.288

NOTE I+J = DP array relative location

TABLE 40. SUPERSONIC SPANWISE LOADING PARAMETER VARIABLES IN DP ARRAY (CONT)

			DP Array Loc Ind	$2\Gamma/V\alpha b$								
				Bm=0.4	Bm=0.6	Bm=0.8	Bm=1.0	Bm=1.3	Bm=2.0	Bm=3.0	Bm=5.0	Bm=12.0
η	λ	BA	I \ J	0	1	2	3	4	5	6	7	8
0.707	1.00	2.0	510	1.390	1.490	1.520	1.512	1.480	1.448	1.422	1.380	1.325
0.707	1.00	3.0	519	1.143	1.335	1.412	1.404	1.350	1.252	1.186	1.125	1.073
0.707	1.00	4.0	528	0.880	1.093	1.215	1.250	1.185	1.085	1.005	0.942	0.895
0.707	1.00	6.0	537	0.622	0.813	0.930	0.980	0.888	0.770	0.705	0.680	0.668
0.707	1.00	12.0	546	0.390	0.525	0.615	0.654	0.520	0.385	0.352	0.342	0.335
0.924	0.0	2.0	555	0.596	0.652	0.696	0.708	0.425	0.300	0.270	0.270	0.270
0.924	0.0	3.0	564	0.495	0.532	0.556	0.560	0.320	0.230	0.205	0.205	0.205
0.924	0.0	4.0	573	0.432	0.464	0.480	0.480	0.246	0.180	0.160	0.160	0.160
0.924	0.0	6.0	582	0.310	0.375	0.387	0.390	0.158	0.118	0.108	0.100	0.100
0.924	0.0	12.0	591	0.202	0.356	0.275	0.275	0.080	0.060	0.057	0.050	0.050
0.924	0.25	2.0	600	0.810	0.794	0.780	0.760	0.725	0.635	0.533	0.490	0.450
0.924	0.25	3.0	609	0.800	0.790	0.770	0.730	0.692	0.536	0.464	0.424	0.395
0.924	0.25	4.0	618	0.790	0.780	0.752	0.720	0.635	0.450	0.400	0.366	0.347
0.924	0.25	6.0	627	0.555	0.670	0.716	0.700	0.490	0.340	0.305	0.280	0.270
0.924	0.25	12.0	636	0.350	0.445	0.495	0.505	0.255	0.190	0.172	0.167	0.161
0.924	0.50	2.0	645	0.805	0.805	0.803	0.800	0.790	0.758	0.664	0.585	0.545
0.924	0.50	3.0	654	0.785	0.785	0.780	0.760	0.703	0.640	0.564	0.510	0.478
0.924	0.50	4.0	663	0.765	0.765	0.755	0.735	0.660	0.550	0.485	0.450	0.421

NOTE I+J = DP array relative location

TABLE 40. SUPERSONIC SPANWISE LOADING PARAMETER VARIABLES IN DP ARRAY (CONCL)

			DP Array Loc Ind	$2\Gamma/Vab$								
				Bm=0.4	Bm=0.6	Bm=0.8	Bm=1.0	Bm=1.3	Bm=2.0	Bm=3.0	Bm=5.0	Bm=12.0
η	λ	BA	I \ J	0	1	2	3	4	5	6	7	8
0.924	0.50	6.0	672	0.740	0.740	0.730	0.710	0.590	0.442	0.383	0.355	0.331
0.924	0.50	12.0	681	0.430	0.550	0.615	0.635	0.375	0.273	0.244	0.228	0.220
0.924	1.00	2.0	690	0.840	0.840	0.840	0.840	0.825	0.822	0.805	0.744	0.712
0.924	1.00	3.0	699	0.795	0.795	0.795	0.795	0.775	0.745	0.685	0.630	0.597
0.924	1.00	4.0	708	0.760	0.760	0.760	0.760	0.748	0.670	0.584	0.540	0.505
0.924	1.00	6.0	717	0.740	0.740	0.740	0.740	0.700	0.540	0.470	0.430	0.400
0.924	1.00	12.0	726	0.710	0.710	0.710	0.710	0.500	0.352	0.310	0.285	0.270

NOTE I+J = DP array relative location

TABLE 41. DR ARRAY, GUST RESPONSE FACTORS

Loc	Value	Engrg Symbol	Description
1	5.0	μ	Air vehicle mass ratio 1
2	10.0	μ	Air vehicle mass ratio 2
3	20.0	μ	Air vehicle mass ratio 3
4	30.0	μ	Air vehicle mass ratio 4
5	40.0	μ	Air vehicle mass ratio 5
6	60.0	μ	Air vehicle mass ratio 6
7	100.0	μ	Air vehicle mass ratio 7
8	140.0	μ	Air vehicle mass ratio 8
9	200.0	μ	Air vehicle mass ratio 9
10	300.0	μ	Air vehicle mass ratio 10
11	0.002	$\bar{C}/L$	Average wing chord to scale of turbulence ratio 1
12	0.004	$\bar{C}/L$	Average wing chord to scale of turbulence ratio 2
13	0.006	$\bar{C}/L$	Average wing chord to scale of turbulence ratio 3
14	0.010	$\bar{C}/L$	Average wing chord to scale of turbulence ratio 4
15	0.015	$\bar{C}/L$	Average wing chord to scale of turbulence ratio 5
16	0.020	$\bar{C}/L$	Average wing chord to scale of turbulence ratio 6
17	0.040	$\bar{C}/L$	Average wing chord to scale of turbulence ratio 7
18	0.060	$\bar{C}/L$	Average wing chord to scale of turbulence ratio 8
19	0.100	$\bar{C}/L$	Average wing chord to scale of turbulence ratio 9
20	0.130	$K\sigma$	Gust response factor for μ, and $\bar{C}/L_1$
.	.	.	Refer to Table 42 for complete gust
109	0.747	$K\sigma$	response factor values.

NOTE

1. DR array starts at common location 2649
2. This array is stored in permanent data file record 9 which is read and used in FATMG.

TABLE 42. GUST RESPONSE FACTORS IN DR ARRAY

DR Array Location Indicator	μ	K_σ								
		C/L 0.002	C/L 0.004	C/L 0.006	C/L 0.010	C/L 0.015	C/L 0.020	C/L 0.040	C/L 0.060	C/L 0.100
J \ I	0	19	29	39	49	59	69	79	89	99
1	5	0.130	0.180	0.210	0.240	0.270	0.300	0.350	0.390	0.430
2	10	0.200	0.250	0.290	0.340	0.380	0.415	0.480	0.520	0.550
3	20	0.270	0.340	0.380	0.440	0.490	0.525	0.590	0.610	0.625
4	30	0.320	0.400	0.450	0.515	0.565	0.595	0.640	0.660	0.660
5	40	0.340	0.440	0.500	0.565	0.615	0.643	0.690	0.695	0.680
6	60	0.410	0.510	0.565	0.632	0.676	0.700	0.735	0.730	0.708
7	100	0.500	0.600	0.655	0.712	0.745	0.762	0.772	0.760	0.725
8	140	0.550	0.650	0.710	0.760	0.782	0.790	0.790	0.770	0.735
9	200	0.620	0.715	0.760	0.800	0.817	0.820	0.805	0.785	0.742
10	300	0.685	0.770	0.805	0.836	0.845	0.843	0.820	0.790	0.747

NOTE; I + J = DR array relative location

TABLE 43. DS ARRAY, BLOCKED MISSION USAGE FOR EIGHT FLIGHT SEGMENTS

Loc	Description
1 . 48	Blocked usage segments for fighter class. Refer to Table 44 for file data values.
49 . 96	Blocked usage segments for attack class. Refer to Table 45 for file data values.
97 . 144	Blocked usage segments for BI class. Refer to Table 46 for file data values.
145 . 192	Blocked usage segments for BII class. Refer to Table 47 for file data values.
193 . 240	Blocked usage segments for cargo-assault class. Refer to Table 48 for file data values.
241 . 288	Blocked usage segments for cargo-transport class. Refer to Table 49 for file data values.

NOTE

1. DS array starts at common location 1889.
2. This array is stored in permanent data file record 5 which is read and used in FATMG.

TABLE 44. TYPICAL BLOCKED USAGE SEGMENTS FOR FIGHTER CLASS IN DS ARRAY

DS Array Location Indicator	Blocked Usage Segment	Average Mach No.	Average Altitude (ft)	Wing Sweep Position	Weight Fraction W/W_o	Life Fraction T/T_L
J \ I	0	8	16	24	32	40
1	1.0 (ascent)	0.70	15.000	1.0 (fixed)	1.00	0.07
2	1.0 (cruise)	0.70	20,000	1.0 (fixed)	0.95	0.15
3	1.0 (cruise)	2.00	40,000	1.0 (fixed)	0.80	0.10
4	1.0 (cruise)	0.90	25,000	1.0 (fixed)	0.80	0.20
5	1.0 (cruise)	0.85	0	1.0 (fixed)	0.80	0.15
6	2.0 (air-ground)	0.80	0	1.0 (fixed)	0.80	0.10
7	3.0 (air-air)	0.80	10,000	1.0 (fixed)	0.75	0.05
8	1.0 (loiter/ descent)	0.60	10,000	1.0 (fixed)	0.70	0.18

NOTE I + J = DS array relative location

TABLE 45. TYPICAL BLOCKED USAGE SEGMENTS FOR ATTACK CLASS IN DS ARRAY

DS Array Location Indicator	Blocked Usage Segment	Average Mach No.	Average Altitude (ft)	Wing Sweep Position	Weight Fraction W/W_o	Life Fraction T/T_L
J \ I	48	56	64	72	80	88
1	1.0 (ascent)	0.70	15,000	1.0 (fixed)	1.00	0.08
2	1.0 (cruise)	0.70	10,000	1.0 (fixed)	0.95	0.25
3	1.0 (cruise)	0.85	40,000	1.0 (fixed)	0.80	0.20
4	1.0 (cruise)	0.80	0	1.0 (fixed)	0.80	0.12
5	3.0 (air-air)	0.95	10,000	1.0 (fixed)	0.75	0.05
6	2.0 (air-ground)	0.80	0	1.0 (fixed)	0.80	0.12
7	1.0 (descent)	0.60	15,000	1.0 (fixed)	0.70	0.08
8	1.0 (loiter)	0.60	10,000	1.0 (fixed)	0.70	0.10

NOTE I + J = DS array relative location

TABLE 46. TYPICAL BLOCKED USAGE SEGMENTS FOR BI CLASS IN DS ARRAY

DS Array Location Indicator	Blocked Usage Segment	Average Mach No.	Average Altitude (ft)	Wing Sweep Position	Weight Fraction W/W_o	Life Fraction T/T_L
J \ I	96	104	112	120	128	136
1	1.0 (ascent)	0.70	15,000	1.0 (fixed)	1.00	0.08
2	1.0 (cruise)	0.70	10,000	1.0 (fixed)	0.95	0.20
3	1.0 (cruise)	0.85	40,000	1.0 (fixed)	0.80	0.25
4	1.0 (cruise)	0.70	0	1.0 (fixed)	0.80	0.12
5	1.0 (cruise)	0.75	5,000	1.0 (fixed)	0.75	0.05
6	1.0 (cruise)	0.60	0	1.0 (fixed)	0.80	0.12
7	1.0 (descent)	0.60	15,000	1.0 (fixed)	0.70	0.08
8	1.0 (loiter)	0.60	10,000	1.0 (fixed)	0.70	0.10

NOTE I + J = DS array relative location

TABLE 47. TYPICAL BLOCKED USAGE SEGMENTS FOR BII CLASS IN DS ARRAY

DS Array Location Indicator	Blocked Usage Segment	Average Mach No.	Average Altitude (ft)	Wing Sweep Position	Weight Fraction W/W_o	Life Fraction T/T_L
J \ I	144	152	160	168	176	184
1	1.0 (ascent)	0.355	0	1.0 (fixed)	1.0	0.104
2	2.0 (cruise)	0.70	30,000	1.0 (fixed)	0.8611	0.0654
3	2.0 (cruise)	0.70	30,000	1.0 (fixed)	0.8611	0.6199
4	1.0 (refuel)	0.70	25,000	1.0 (fixed)	1.0833	0.0407
5	2.0 (cruise)	2.20	50,000	1.0 (fixed)	0.6944	0.0269
6	3.0 (penetrate)	0.85	0	1.0 (fixed)	0.8611	0.1081
7	3.0 (penetrate)	0.95	0	1.0 (fixed)	0.6944	0.0232
8	3 0 (penetrate)	0.55	0	1.0 (fixed)	0.75	0.0118

NOTE I + J = DS array relative location

TABLE 48. TYPICAL BLOCKED USAGE SEGMENTS FOR CARGO-ASSAULT CLASS IN DS ARRAY

DS Array Location Indicator	Blocked Usage Segment	Average Mach No.	Average Altitude (ft)	Wing Sweep Position	Weight Fraction W/W_o	Life Fraction T/T_L
J \ I	192	200	208	216	224	232
1	1.0 (ascent/ descent)	0.60	20,000	1.0 (fixed)	0.94	0.2185
2	1.0 (ascent)	0.60	20,000	1.0 (fixed)	1.10	0.0044
3	1.0 (ascent/ descent)	0.40	5,000	1.0 (fixed)	0.94	0.0332
4	2.0 (cruise)	0.75	40,000	1.0 (fixed)	0.94	0.3341
5	2.0 (cruise)	0.75	40,000	1.0 (fixed)	1.06	0.0255
6	2.0 (cruise)	0.65	20,000	1.0 (fixed)	0.94	0.0354
7	2.0 (cruise)	0.47	10,000	1.0 (fixed)	0.91	0.0135
8	2.0 (cruise)	0.456	1,000	1.0 (fixed)	0.91	0.3354

NOTE I + J = DS array relative location

TABLE 49. TYPICAL BLOCKED USAGE SEGMENTS FOR CARGO-TRANSPORT CLASS IN DS ARRAY

DS Array Location Indicator	Blocked Usage Segment	Average Mach No.	Average Altitude (ft)	Wing Sweep Position	Weight Fraction W/W_o	Life Fraction T/T_L
J \ I	240	248	256	264	272	280
1	1.0 (ascent)	0.50	20,000	1.0 (fixed)	1.00	0.05
2	1.0 (ascent/descent)	0.50	10,000	1.0 (fixed)	0.70	0.05
3	2.0 (cruise)	0.80	30,000	1.0 (fixed)	0.80	0.25
4	2.0 (cruise)	0.85	40,000	1.0 (fixed)	0.75	0.30
5	2.0 (cruise)	0.75	25,000	1.0 (fixed)	0.80	0.15
6	2.0 (cruise)	0.70	15,000	1.0 (fixed)	0.70	0.10
7	2.0 (cruise)	0.65	10,000	1.0 (fixed)	0.70	0.05
8	2.0 (cruise)	0.55	1,000	1.0 (fixed)	0.70	0.05

NOTE: I + J = DS array relative location

TABLE 50. DT ARRAY, AERODYNAMIC DATA

Loc	Value	Engrg Symbol	Description
1	0.0	η_1	Normalized spanwise station 1
2	0.383	η_2	Normalized spanwise station 2
3	0.707	η_3	Normalized spanwise station 3
4	0.924	η_4	Normalized spanwise station 4
5	0.0	λ_1	Taper ratio 1
6	0.250	λ_2	Taper ratio 2
7	0.500	λ_3	Taper ratio 3
8	1.000	λ_4	Taper ratio 4
9	0.20	M_1	Mach No. 1
10	0.60	M_2	Mach No. 2
11	0.80	M_3	Mach No. 3
12	0.90	M_4	Mach No. 4
13	0.95	M_5	Mach No. 5
14	1.00	M_6	Mach No. 6
15	1.05	M_7	Mach No. 7
16	1.10	M_8	Mach No. 8
17	1.15	M_9	Mach No. 9
18	1.20	M_{10}	Mach No. 10
19	2.00	M_{11}	Mach No. 11
20	3.50	M_{12}	Mach No. 12

TABLE 50. DT ARRAY, AERODYNAMIC DATA (CONT)

Loc	Value	Engrg Symbol	Description
21	1.080	B/K_1	Compressible lift-curve slope factor at M_1
22	0.878	B/K_2	Compressible lift-curve slope factor at M_2
23	0.645	B/K_3	Compressible lift-curve slope factor at M_3
24	0.500	B/K_4	Compressible lift-curve slope factor at M_4
25	0.358	B/K_5	Compressible lift-curve slope factor at M_5
26	0.0	B/K_6	Compressible lift-curve slope factor at M_6
27	0.0	B/K_7	Compressible lift-curve slope factor at M_7
28	0.0	B/K_8	Compressible lift-curve slope factor at M_8
29	0.0	B/K_9	Compressible lift-curve slope factor at M_9
30	0.0	B/K_{10}	Compressible lift-curve slope factor at M_{10}
31	0.0	B/K_{11}	Compressible lift-curve slope factor at M_{11}
32	0.0	B/K_{12}	Compressible lift-curve slope factor at M_{12}
33	0.330	X/C_1	Local wing CP at M_1
34	0.338	X/C_2	Local wing CP at M_2
35	0.390	X/C_3	Local wing CP at M_3
36	0.520	X/C_4	Local wing CP at M_4
37	0.560	X/C_5	Local wing CP at M_5
38	0.574	X/C_6	Local wing CP at M_6
39	0.580	X/C_7	Local wing CP at M_7
40	0.580	X/C_8	Local wing CP at M_8

TABLE 50. DT ARRAY, AERODYNAMIC DATA (CONCL)

Loc	Value	Engrg Symbol	Description
41	0.580	X/C_9	Local wing CP at M_9
42	0.580	X/C_{10}	Local wing CP at M_{10}
43	0.580	X/C_{11}	Local wing CP at M_{11}
44	0.580	X/C_{12}	Local wing CP at M_{12}
45	0.230	X/C_1	Local tail CP at M_1
46	0.230	X/C_2	Local tail CP at M_2
47	0.245	X/C_3	Local tail CP at M_3
48	0.313	X/C_4	Local tail CP at M_4
49	0.395	X/C_5	Local tail CPat M_5
50	0.430	X/C_6	Local tail CP at M_6
51	0.442	X/C_7	Local tail CP at M_7
52	0.448	X/C_8	Local tail CP at M_8
53	0.448	X/C_9	Local tail CP at M_9
54	0.448	X/C_{10}	Local tail CP at M_{10}
55	0.448	X/C_{11}	Local tail CP at M_{11}
56	0.448	X/C_{12}	Local tail CP at M_{12}

NOTE

1. DT array starts at common location 100.

2. This array is stored in permanent data file record 1, read in BLCNTL, and used in USPAN.

TABLE 51. DUM ARRAY VARIABLES

Loc	Description
1 - 11	Positive design airload shear times temperature normalizing factor at wing weight analysis stations 11 to 1 (tip to root)
12 - 22	Negative design airload shear times temperature normalizing factor at wing weight analysis stations 11 to 1 (tip to root)
23 - 33	Positive design airload bending moment times temperature normalizing factor at wing weight analysis stations 11 to 1
34 - 44	Negative design airload bending moment times temperature normalizing factor at wing weight analysis stations 11 to 1
45 - 55	Positive design airload shear times temperature normalizing factor at horizontal tail weight analysis stations 11 to 1
56 - 66	Negative design airload shear times temperature normalizing factor at horizontal tail weight analysis stations 11 to 1
67 - 77	Positive design airload bending moment times temperature normalizing factor at horizontal tail weight analysis stations 11 to 1
78 - 88	Negative design airload bending moment times temperature normalizing factor at horizontal tail weight analysis stations 11 to 1
89 - 99	Positive design airload shear times temperature normalizing factor at vertical tail weight analysis stations 11 to 1
100 - 110	Negative design airload shear times temperature normalizing factor at vertical tail weight analysis stations 11 to 1
111 - 121	Positive design airload bending moment times temperature normalizing factor at vertical tail weight analysis stations 11 to 1

TABLE 51. DUM ARRAY VARIABLES (CONCL)

Loc	Description
122 - 132	Negative design airload bending moment times temperature normalizing factor at vertical tail weight analysis stations 11 to 1
133 - 143	Airload torque at positive design bending moment condition times temperature normalizing factor at wing weight analysis stations 11 to 1
144 - 154	Airload torque at negative design bending moment condition times temperature normalizing factor at wing weight analysis stations 11 to 1
155 - 165	Airload torque at positive design bending moment condition times temperature normalizing factor at horizontal factor at horizontal tail weight analysis stations 11 to 1
166 - 176	Airload torque at negative design bending moment condition times temperature normalizing factor at horizontal tail weight analysis stations 11 to 1
177 - 187	Airload torque at positive design bending moment condition times temperature normalizing factor at vertical tail weight analysis stations 11 to 1
188 - 198	Airload torque at negative design bending moment condition times temperature normalizing factor at vertical tail weight analysis stations 11 to 1

NOTE DUM array starts at common location 5522.

TABLE 52. IDUM ARRAY VARIABLES

Loc	Description
1 - 11	Load conditions that produce design net positive shear at wing weight analysis stations 11 to 1
12 - 22	Load conditions that produce design net negative shear at wing weight analysis stations 11 to 1
23 - 33	Load conditions that produce design net positive bending moment at wing weight analysis stations 11 to 1
34 - 44	Load conditions that produce design net negative bending moment at wing weight analysis stations 11 to 1
45 - 55	Load conditions that produce design net positive shear at horizontal tail weight analysis stations 11 to 1
56 - 66	Load conditions that produce design net negative shear at horizontal tail weight analysis stations 11 to 1
67 - 77	Load conditions that produce design net positive bending moment at horizontal tail weight analysis stations 11 to 1
78 - 88	Load conditions that produce design net negative bending moment at horizontal tail weight analysis stations 11 to 1
89 - 99	Load conditions that produce design net positive shear at vertical tail weight analysis stations 11 to 1
100 - 110	Load conditions that produce design net negative shear at vertical tail weight analysis stations 11 to 1
111 - 121	Load conditions that produce design net positive bending moment at vertical tail weight analysis stations 11 to 1
122 - 132	Load conditions that produce design net negative bending moment at vertical tail weight analysis stations 11 to 1
NOTE IDUM array starts at common location 4701.	

TABLE 53. ND ARRAY VARIABLES

Loc	Variable Name	Description	Subroutine Reference
1		Not used	
.			
12		Not used	
13	NA	Air vehicle category indicator 1 = fighter (F) 2 = attack (A) 3 = tactical bomber (BI) 4 = strategic bomber (BII) 5 = cargo assault (CA) 6 = cargo transport (CT)	BLCNTL, FATMG
14		Wing type indicator -1 = fized wing 1 = variable sweep wing	BLCNTL, FATMG
15		Vertical tail type indicator -1 = single tail 0 = dual tail 1 = T-type tail	BLCNTL, BNLDS, SPABM
16		Load calculation option indicator -1 = basic loads only 0 = fatigue spectra only 1 = basic loads and fatigue spectra	BLCNTL
17		Not used	
.			
22		Not used	
23		Basic load calculation option indicator 1 = compute all loads (fuselage, wing, horizontal, vertical) 0 = compute loads as indicated by following controls (ND(24) through ND(27))	BLCNTL, USPAN, BNLDS, SPABM, MAXLDS, WHVNET

TABLE 53. ND ARRAY VARIABLES (CONT)

Loc	Variable Name	Description	Subroutine Reference
24		Fuselage load calculation option indicator 1 = compute fuselage loads 0 = do not compute fuselage loads	BLCNTL, USPAN, BNLDS
25		Wing load calculation option indicator 1 = compute wing loads 0 = do not compute wing loads	BLCNTL, USPAN, SPABM, MAXLDS, WHVNET
26		Horizontal tail load calculation option indicator 1 = compute horizontal tail loads 0 = do not compute horizontal tail loads	BLCNTL, USPAN, SPABM, MAXLDS, WHVNET
27		Vertical tail load calculation option indicator 1 = compute vertical tail loads 0 = do not compute vertical tail loads	BLCNTL, USPAN, SPABM, MAXLDS, WHVNET
28		Load conditions 1 through 5 ($+N_z$) calculation option indicator 1 = compute loads for conditions 0 = do not compute loads	BLCNTL
29		Load conditions 6 and 7 ($-N_z$) calculation option indicator 1 = compute loads for conditions 0 = do not compute loads	BLCNTL
30		Load condition 8, flaps down maneuver, calculation option indicator 1 = compute loads for condition 0 = do not compute loads	BLCNTL
31		Load condition 9, 1 g flaps down trim, calculation option indicator 1 = compute loads 0 = do not compute loads	BLCNTL

TABLE 53. ND ARRAY VARIABLES (CONT)

Loc	Variable Name	Description	Subroutine Reference
32		Load conditions 10 through 13, positive vertical gust, calculation option indicator 1 = compute loads 0 = do not compute loads	BLCNTL
33		Load conditions 14 through 17, negative vertical gust, calculation option indicator 1 = compute loads 0 = do not compute loads	BLCNTL
34		Load conditions 18 and 19, lateral gust, calculation option indicator 1 = compute loads 0 = do not compute loads	BLCNTL
35		Load conditions 20 and 21, pitching acceleration, calculation option indicator 1 = compute loads 0 = do not compute loads	BLCNTL
36		Load conditions 22 and 23, yawing acceleration, calculation option indicator 1 = compute loads 0 = do not compute loads	BLCNTL
37		Not used	
38		Not used	
39		Fatigue spectra option indicator -1 = compute gust and maneuver spectra 1 = compute gust spectra only	BLCNTL, FATMG

TABLE 53. ND ARRAY VARIABLES (CONT)

Loc	Variable Name	Description	Subroutine Reference
40		Not used	
.			
100		Not used	
101	I	Scratch counter and load condition counter	BLCNTL, MAXLDS
102		Not used	
103		Not used	
104		Not used	
105	IN	Load calculation control, if ND(28) through ND(36) = 0, then set ND(28) through ND(36) = 1	BLCNTL
106	NI	Load condition grouping indicator 1 = conditions 1 through 7 2 = condition 8 3 = condition 9 4 = conditions 10 through 13 5 = conditions 14 through 17 6 = conditions 18 and 19 7 = conditions 20 and 21 8 = conditions 22 and 23	BLCNTL, BNLDS
107		Not used	
108	NF	Loads distribution calculation control -1 = all surfaces 1 = wing only, flaps up	BLCNTL, USPAN, FATMG
109		Condition 1 indicator 1 = compute loads 0 = do not compute loads	BLCNTL, MAXLDS, FUSNET

TABLE 53. ND ARRAY VARIABLES (CONT)

Loc	Variable Name	Description	Subroutine Reference
110		Condition 2 indicator 1 = compute loads 0 = do not compute loads	BLCNTL, MAXLDS, FUSNET
111		Condition 3 indicator	BLCNTL, MAXLDS, FUSNET
112		Condition 4 indicator	BLCNTL, MAXLDS, FUSNET
113		Condition 5 indicator	BLCNTL, MAXLDS, FUSNET
114		Condition 6 indicator	BLCNTL, MAXLDS, FUSNET
115		Condition 7 indicator	BLCNTL, MAXLDS, FUSNET
116		Condition 8 indicator	BLCNTL, MAXLDS, FUSNET
117		Condition 9 indicator	BLCNTL, MAXLDS FUSNET
118		Condition 10 indicator	BLCNTL, MAXLDS, FUSNET
119		Condition 11 indicator	BLCNTL, MAXLDS, FUSNET
120		Condition 12 indicator	BLCNTL, MAXLDS, FUSNET
121		Condition 13 indicator	BLCNTL, MAXLDS, FUSNET
122		Condition 14 indicator	BLCNTL, MAXLDS, FUSNET
123		Condition 15 indicator	BLCNTL, MAXLDS, FUSNET
124		Condition 16 indicator	BLCNTL, MAXLDS, FUSNET
125		Condition 17 indicator	BLCNTL, MAXLDS, FUSNET
126		Condition 18 indicator	BLCNTL, MAXLDS, FUSNET
127		Condition 19 indicator	BLCNTL, MAXLDS, FUSNET
128		Condition 20 indicator	BLCNTL, MAXLDS, FUSNET

TABLE 53. ND ARRAY VARIABLES (CONT)

Loc	Variable Name	Description	Subroutine Reference
129		Condition 21 indicator	BLCNTL, MAXLDS, FUSNET
130		Condition 22 indicator	BLCNTL, MAXLDS, FUSNET
131		Condition 23 indicator	BLCNTL, MAXLDS, FUSNET
132	I	Scratch counter	USPAN
133	J	Scratch counter	USPAN
134	K	Scratch counter	USPAN
135	L	Scratch counter	USPAN
136	NT	Surface indicator 1 = wing (basic) 2 = deflected flaps 3 = horizontal tail 4 = single or dual vertical tail 5 = T-type tail	USPAN
137	IP	Wing type and position indicator -1 = fixed wing 0 = variable sweep wing, forward position 1 = variable sweep wing, aft position	USPAN, BNLDS, SPABM, FUSNET
138	N3	Curve value counter	FCODM2
139	N4	Number of curves interpolations	FCODM2
140	I	Scratch counter	FCODM2
141	K	Scratch counter	FCODM2
142	L	Curve family data location counter	FCODM2
143	N1	Number of data points describing the function	CODIM2

TABLE 53. ND ARRAY VARIABLES (CONT)

Loc	Variable Name	Description	Subroutine Reference
144	J	Data point location counter	CODIM2
145	JJ	Data point region indicator	CODIM2
146	K	Scratch counter	CODIM2
147	L	Scratch counter	CODIM2
148	M	Scratch counter	CODIM2
149	M	Scratch counter	USPAN
150	NT	Surface indicator 1 = wing 2 = body in presence of wing 3 = horizontal tail 4 = vertical tail	BNLDS
151	I	Scratch counter	BNLDS
152	J	Scratch counter	BNLDS
153	K	Scratch counter	BNLDS
154	ID	Surface indicator 1 = wing (basic) 2 = deflected flaps 3 = horizontal tail 4 = dual vertical tail 5 = single vertical tail 6 = T-type tail	SPABM
155	I	Scratch counter	SPABM
156	J	Scratch counter	SPABM
157	K	Scratch counter	SPABM
158	L	Scratch counter	SPABM

TABLE 53. ND ARRAY VARIABLES (CONT)

Loc	Variable Name	Description	Subroutine Reference
159	M	Scratch counter	SPABM
160	NS	Mission segment counter	FATMG
161	NG	Scratch counter	FATMG
162	NN	Scratch counter	FATMG
163	NY	Mission segment type for DE file access	FATMG

Value	A/V Class	Segment
1	F, A	ascent, cruise, loiter, or descent
2	F, A	air-to-ground combat
3	F, A	subsonic air-to-air combat
4	F, A	supersonic air-to-air combat
1	BI	all mission segments
1	BII	ascent, descent, or refueling
2	BII	cruise or high-altitude penetration
3	BII	low-altitude penetration
1	CA, CT	ascent, descent, or refueling
2	CA, CT	cruise

TABLE 53. ND ARRAY VARIABLES (CONCL)

Loc	Variable Name	Description	Subroutine Reference
164	I	Scratch counter	FATMG
165	J	Scratch counter	FATMG
166	K	Scratch counter	FATMG
167	L	Scratch counter	FATMG
168	M	Scratch counter	FATMG
169		Not used	
.			
200		Not used	

NOTE ND array starts at common location 4201

TABLE 54. RC ARRAY VARIABLES

Loc	Description
1 - 11	Ratios of shear due to contents at positive net shear condition to shear due to contents at BFDW for wing weight analysis stations 11 to 1
12 - 22	Ratios of shear due to contents at negative net shear condition to shear due to contents at BFDW for wing weight analysis stations 11 to 1
23 - 33	Ratios of bending moment due to contents at positive net bending moment condition to bending moment due to contents at BFDW for wing weight analysis stations 11 to 1
34 - 44	Ratios of bending moment due to contents at negative net bending moment condition to bending moment due to contents at BFDW for wing weight analysis stations 11 to 1

NOTE RC array starts at common location 5229.

TABLE 55. RNZ ARRAY VARIABLES

Loc	Description
1 - 11	Ratios of load factor at positive net shear condition to maximum positive load factor for wing weight analysis stations 11 to 1
12 - 22	Ratios of load factor at negative net shear condition to maximum negative load factor for wing weight analysis stations 11 to 1
23 - 33	Ratios of load factor at positive net bending moment condition to maximum positive load factor for wing weight analysis stations 11 to 1
34 - 44	Ratios of load factor at negative net bending moment condition to maximum negative load factor for wing weight analysis stations 11 to 1
45 - 55	Ratios of load factor at positive net shear condition to maximum positive load factor for horizontal tail weight analysis stations 11 to 1
56 - 66	Ratios of load factor at negative net shear condition to maximum negative load factor for horizontal tail weight analysis stations 11 to 1
67 - 77	Ratios of load factor at positive net bending moment condition to maximum positive load factor for horizontal tail weight analysis stations 11 to 1
78 - 88	Ratios of load factor at negative net bending moment condition to maximum negative load factor for horizontal tail weight analysis stations 11 to 1
89 - 99	Ratios of load factor at positive net shear condition to maximum positive load factor for vertical tail weight analysis stations 11 to 1
100 - 110	Ratios of load factor at negative net shear condition to maximum negative load factor for vertical tail weight analysis stations 11 to 1

TABLE 55. RNZ ARRAY VARIABLES (CONCL)

Loc	Description
111 - 121	Ratios of load factor at positive net bending moment condition to maximum positive load factor for vertical tail weight analysis stations 11 to 1
122 - 132	Ratios of load factor at negative net bending moment condition to maximum negative load factor for vertical tail weight analysis stations 11 to 1

NOTE RNZ array starts at common location 5097.

TABLE 56. SAVE ARRAY VARIABLES

Loc	Description
1 - 11	Design positive airload shear at wing weight analysis stations 11 to 1
12 - 22	Design negative airload shear at wing weight analysis stations 11 to 1
23 - 33	Design positive airload bending moment at wing weight analysis stations 11 to 1
34 - 44	Design negative airload bending moment at wing weight analysis stations 11 to 1
45 - 55	Design positive airload shear at horizontal tail weight analysis stations 11 to 1
56 - 66	Design negative airload shear at horizontal tail weight analysis stations 11 to 1
67 - 77	Design positive airload bending moment at horizontal tail weight analysis stations 11 to 1
78 - 88	Design negative airload bending moment at horizontal tail weight analysis stations 11 to 1
89 - 99	Design positive airload shear at vertical tail weight analysis stations 11 to 1
100 - 110	Design negative airload shear at vertical tail weight analysis stations 11 to 1
111 - 121	Design positive airload bending moment at vertical tail weight analysis stations 11 to 1
122 - 132	Design negative airload bending moment at vertical tail weight analysis stations 11 to 1

NOTE Save array starts at common location 4833.

TABLE 57. SAVET ARRAY VARIABLES

Loc	Description
1 - 11	Airload torque at positive design bending moment conditions at wing weight analysis stations 11 to 1
12 - 22	Airload torque at negative design bending moment conditions at wing weight analysis stations 11 to 1
23 - 33	Airload torque at positive design bending moment conditions at horizontal tail weight analysis stations 11 to 1
34 - 44	Airload torque at negative design bending moment conditions at horizontal tail weight analysis stations 11 to 1
45 - 55	Airload torque at positive design bending moment conditions at vertical tail weight analysis stations 11 to 1
56 - 66	Airload torque at negative design bending moment conditions at vertical tail weight analysis stations 11 to 1

NOTE SAVET array starts at common location 5720.

TABLE 58. SVT ARRAY VARIABLES

Loc	Variable Name	Description
1	PSI (1)	Ambient pressure at load condition 1, psi
.	.	to
23	PSI (23)	Ambient pressure at load condition 23, psi
24	TLOCAL (1)	Ambient temperature at load condition 1, °R
.	.	to
46	TLOCAL (23)	Ambient temperature at load condition 23, °R
47	TTOTAL (1)	Total Temperature at load condition 1, °R
.	.	to
69	TTOTAL (23)	Total temperature at load condition 23, °R
70	SFLUX (1)	Sun flux at load condition 1, BTU/hr/ft^2
.	.	to
92	SFLUX (23)	Sun flux at load condition 23, BTU/hr/ft^2
93	TSKINR (1)	Equilibrium skin temperature at load condition 1, °R
.	.	to
115	TSKINR (23)	Equilibrium skin temperature at load condition 23, °R
116	TSKINF (1)	Equilibrium skin temperature at load condition 1, °F
.	.	to
138	TSKINF (23)	Equilibrium skin temperature at load condition 23, °F
139	STW (1)	Wing material compression yield stress at library temperature 1, psi
.	.	to
144	STW (6)	Wing material compression yield stress at library temperature 6, psi
145	TEMPW (1)	Wing material library temperature 1, °F
.	.	to
150	TEMPW (6)	Wing material library temperature 6, °F
151	NWING	Number of values in wing stress-G-temperature table
152	S80W	Wing material compression yield stress at 80° F
153	STH (1)	Horizontal tail material compression yield stress at library temperature 1, psi
.	.	

TABLE 58. SVF ARRAY VARIABLES (CONCL)

Loc	Variable Name	Description
158	STH (6)	Horizontal tail material compression yield stress at library temperature 6, psi
159 • 164	TEMPH (1) • TEMPH (6)	Horizontal tail material library temperature 1, °F to Horizontal tail material library temperature 6, °F
165	NHOR	Number of values in horizontal tail stress-G-temperature table
166	S80H	Horizontal tail material compression yield stress at 80° F
167 • 172	STV (1) • STV (6)	Vertical tail material compression yield stress at library temperature 1, psi to Vertical tail material compression yield stress at library temperature 6, psi
173 • 178	TEMPV (1) • TEMPV (6)	Vertical tail material library temperature 1, °F to Vertical tail material library temperature 6, °F
179	NVER	Number of values in vertical tail stress-G-temperature table
180	S80V	Vertical tail material compression yield stress at 80° F

Note: SVF array starts at common location 5273

TABLE 59. WLD ARRAY VARIABLES

Loc	Variable Name	Description
1	BDGW	Basic flight design weight (BFDW), lb
2	POSNZ	Maximum positive maneuver load factor
3	XNEGNZ	Maximum negative maneuver load factor
4	V2G(1)	Wing net shear at 2 g taxi at wing weight analysis station 1 (wing fixed or forward)
.	.	Outboard to
.	.	
.	.	
14	V2G(11)	Wing net shear at 2 g taxi at wing weight analysis station 11 (wing fixed or forward)
15	BM2G(1)	Wing net bending moment at 2 g taxi at wing weight analysis station 1 (wing fixed or forward)
.	.	Outboard to
.	.	
.	.	
25	BM2G(11)	Wing net bending moment at 2 g taxi at wing weight analysis station 11 (wing fixed or forward)
26	T2G(1)	Wing net torque at 2 g taxi at wing weight analysis station 1 (wing fixed or forward)
.	.	Outboard to
.	.	
.	.	
36	T2G(11)	Wing net torque at 2 g taxi at wing weight analysis station 11 (wing fixed or forward)
37	VW1(1)	Wing only 1 g inertia shear at wing weight analysis station 1 (wing fixed or aft)
.	.	Outboard to
.	.	
.	.	
47	VW1(11)	Wing only 1 g inertia shear at wing weight analysis station 11 (wing fixed or aft)
48	BMW1(1)	Wing only 1 g inertia bending moment at wing weight analysis station 1 (wing fixed or aft)
.	.	Outboard to
.	.	
.	.	
58	BMW1(11)	Wing only 1 g inertia bending moment at wing weight analysis station 11 (wing fixed or aft)

TABLE 59. WLD ARRAY VARIABLES (CONT)

Loc	Variable Name	Description
59	TW1(1)	Wing only 1 g inertia torque at wing weight analysis station 1 (wing fixed or aft
.	.	Outboard to
.	.	
.	.	
69	TW1(11)	Wing only 1 g inertia torque at wing weight analysis station 11 (wing fixed or aft)
70	VW2(1)	Wing only 1 g inertia shear at wing weight analysis station 1 (wing fixed or forward)
.	.	Outboard to
.	.	
.	.	
80	VW2(11)	Wing only 1 g inertia shear at wing weight analysis station 11 (wing fixed or forward)
81	BMW2(1)	Wing only 1 g inertia bending moment at wing weight analysis station 1 (wing fixed or forward)
.	.	Outboard to
.	.	
.	.	
91	BMW2(11)	Wing only 1 g inertia bending moment at wing weight analysis station 11 (wing fixed or forward)
92	TW2(1)	Wing only 1 g inertia torque at wing weight analysis station 1 (wing fixed or forward)
.	.	Outboard to
.	.	
.	.	
102	TW2(11)	Wing only 1 g inertia torque at wing weight analysis station 11 (wing fixed or forward)
103	V21(1)	Wing and content 1 g inertia shear at MDW at wing weight analysis station 1 (wing fixed or forward)
.	.	Outboard to
.	.	
.	.	
113	V21(11)	Wing and content 1 g inertia shear at MDW at wing weight analysis station 11 (wing fixed or forward)
114	BM21(1)	Wing and content 1 g inertia bending moment at MDW at wing weight analysis station 1 (wing fixed or forward)
.	.	Outboard to
.	.	
.	.	
124	BM21(11)	Wing and content 1 g inertia bending moment at MDW at wing weight analysis station 11 (wing fixed or forward)

TABLE 59. WLD ARRAY VARIABLES (CONT)

Loc	Variable Name	Description
125	T21(1)	Wing and content 1 g inertia torque at MDW at wing weight analysis station 1 (wing fixed or forward) Outboard to
.	.	
.	.	
.	.	
135	T21(11)	Wing and content 1 g inertia torque at MDW at wing weight analysis station 11 (wing fixed or forward)
136	V12(1)	Wing and content 1 g inertia shear at BFDW at wing weight analysis station 1 (wing fixed or aft) Outboard to
.	.	
.	.	
.	.	
146	V12(11)	Wing and content 1 g inertia shear at BFDW at wing weight analysis station 11 (wing fixed or aft)
147	BM12(1)	Wing and content 1 g inertia bending moment at BFDW at wing weight analysis station 1 (wing fixed or aft) Outboard to
.	.	
.	.	
.	.	
157	BM12(11)	Wing and content 1 g inertia bending moment at BFDW at wing weight analysis station 11 (wing fixed or aft)
158	T12(1)	Wing and content 1 g inertia torque at BFDW at wing weight analysis station 1 (wing fixed or aft) Outboard to
.	.	
.	.	
.	.	
168	T12(11)	Wing and content 1 g inertia torque at BFDW at wing weight analysis station 11 (wing fixed or aft)
169	V22(1)	Wing and content 1 g inertia shear at BFDW at wing weight analysis station 1 (wing fixed or forward) Outboard to
.	.	
.	.	
.	.	
179	V22(11)	Wing and content 1 g inertia shear at BFDW at wing weight analysis station 11 (wing fixed or forward)
180	BM22(1)	Wing and content 1 g inertia bending moment at BFDW at wing weight analysis station 1 (wing fixed or forward) Outboard to
.	.	
.	.	
.	.	
190	BM22(11)	Wing and content 1 g inertia bending moment at BFDW at wing weight analysis station 11 (wing fixed or forward)

TABLE 59. WLD ARRAY VARIABLES (CONT)

Loc	Variable Name	Description
191 . . .	T22(1) . . .	Wing and content 1 g inertia torque at BFDW at wing weight analysis station 1 (wing fixed or forward) Outboard to
201	T22(11)	Wing and content 1 g inertia torque at BFDW at wing weight analysis station 11 (wing fixed or forward)
202 . . .	V23(1) . . .	Wing and content 1 g inertia shear at LDW at wing weight analysis station 1 (wing fixed or forward) Outboard to
212	V23(11)	Wing and content 1 g inertia shear at LDW at wing weight analysis station 11 (wing fixed or forward)
213 . . .	BM23(1) . . .	Wing and content 1 g inertia bending moment at LDW at wing weight analysis station 1 (wing fixed or forward) Outboard to
223	BM23(11)	Wing and content 1 g inertia bending moment at LDW at wing weight analysis station 11 (wing fixed or forward)
224 . . .	T23(1) . . .	Wing and content 1 g inertia torque at LDW at wing weight analysis station 1 (wing fixed or forward) Outboard to
234	T23(11)	Wing and content 1 g inertia torque at LDW at wing weight analysis station 11 (wing fixed or forward)
235 . . .	VH(1) . . .	Horizontal tail and content 1 g inertia shear at weight analysis station 1 Outboard to
245	VH(11)	Horizontal tail and content 1 g inertia shear at weight analysis station 11
246 . . .	BMH(1) . . .	Horizontal tail and content 1 g inertia bending moment at weight analysis station 1 Outboard to
256	BMH(11)	Horizontal tail and content 1 g inertia bending moment at weight analysis station 11

TABLE 59. WLD ARRAY VARIABLES (CONCL)

Loc	Variable Name	Description
257 . . .	TH(1) . . .	Horizontal tail and content 1 g inertia torque at weight analysis station 1 Outboard to
267	TH(11)	Horizontal tail and content 1 g inertia torque at weight analysis station 11
268 . . .	VV(1) . . .	Vertical tail and content 1 g (lateral) inertia shear at weight analysis station 1 Outboard to
278	VV(11)	Vertical tail and content 1 g (lateral) inertia shear at weight analysis station 11
279 . . .	BMV(1) . . .	Vertical tail and content 1 g (lateral) inertia bending moment at weight analysis station 1 Outboard to
289	BMV(11)	Vertical tail and content 1 g (lateral) inertia bending moment at weight analysis station 11
290 . . .	TV(1) . . .	Vertical tail and content 1 g (lateral) inertia torque at weight analysis station 1 Outboard to
300	TV(11)	Vertical tail and content 1 g (lateral) inertia torque at weight analysis station 11

NOTE: WLD array starts at common location 4401

TABLE 60. XNET ARRAY VARIABLES

Loc	Description
1 - 11	Net positive design shear normalized to room temperature (80°F) reference at wing weight analysis stations 11 to 1
12 - 22	Net negative design shear normalized to room temperature reference at wing weight analysis stations 11 to 1
23 - 33	Net positive design bending moment normalized to room temperature reference at wing weight analysis stations 11 to 1
34 - 44	Net negative design bending moment normalized to room temperature reference at wing weight analysis stations 11 to 1
45 - 55	Net positive design shear normalized to room temperature reference at horizontal tail weight analysis stations 11 to 1
56 - 66	Net negative design shear normalized to room temperature reference at horizontal tail weight analysis stations 11 to 1
67 - 77	Net positive design bending moment normalized to room temperature reference at horizontal tail weight analysis stations 11 to 1
78 - 88	Net negative design bending moment normalized to room temperature reference at horizontal tail weight analysis stations 11 to 1
89 - 99	Net positive design shear normalized to room temperature reference at vertical tail weight analysis stations 11 to 1
100 - 110	Net negative design shear normalized to room temperature reference at vertical tail weight analysis stations 11 to 1
111 - 121	Net positive bending moment normalized to room temperature reference at vertical tail weight analysis stations 11 to 1

TABLE 60. XNET ARRAY VARIABLES (CONCL)

Loc	Descriptions
122 - 132	Net negative bending moment normalized to room temperature reference at vertical tail weight analysis stations 11 to 1

NOTE

1. XNET array starts at common location 4965.
2. The temperature normalizing factors are the ratio of structure material compression yield strength at 80°F to compression yield strength at design load condition.

TABLE 61. XMISC ARRAY VARIABLES (MISC BLOCK)

Loc	Description	Subroutine Reference
1 . 7	Controls and design data used by other program modules	
8	Wing design temperature, temperature associated with maximum positive net bending moment at root weight analysis station, °F	WHVNET
9	Horizontal tail design temperature, temperature associated with maximum net bending moment at root weight analysis station, °F	WHVNET
10	Vertical tail design temperature, temperature associated with maximum net bending moment at root weight analysis station, °F	WHVNET
11 . 14	Controls and design data used by other program modules	
15	Wing structure material identification number; established in executive module	MAXLDS, WHVNET,
16 . 18	Controls and design data used by other program modules	
19	Horizontal tail structure material identification number; established in input data processing module	MAXLDS, WHVNET,
20 . 22	Controls and desing data used by other program modules	

TABLE 61. XMISC ARRAY VARIABLES (MISC BLOCK) (CONT)

Loc	Description	Subroutine Reference
23	Vertical tail structure material identification number, established in executive module	MAXLDS, WBNET
24 • 30	Controls and design data used by other program modules	
31	Control used by other program modules	
32	Maximum net unswept bending moment at wing side of fuselage station for fatigue evaluation, in.-lb	BLCNTL
33	Maximum net swept bending moment at wing outboard station for fatigue evaluation, in.-lb	BLCNTL
34	Design data used by other program modules	
35	Vehicle sink speed at landing condition; established in executive module, ft/sec	FUSNET
36	Main landing gear stroke; established in executive module, in.	FUSNET
37	Ratio of ultimate to limit loads; established in executive module	FUSNET
38	Taxi load factor; established in executive module	FUSNET
39 • 41	Controls and design data used by other program modules	

TABLE 61. XMISC ARRAY VARIABLES (MISC BLOCK) (CONT)

Loc	Description	Subroutine Reference
42	Indicator to designate that horizontal tail loads have been reversed 0 = loads have not been reversed 1 = loads have been reversed	WHVNET
Locations 43 through 50 contain inertia bending per g at the fatigue evaluation stations; these values are established in the data management module.		
43	Unswept bending moment at basic flight design weight for wings fixed or aft at station 1, in.-lb	BLCNTL
44	Swept bending moment at basic flight design weight for wings fixed or aft at station 2, in.-lb	BLCNTL
45	Unswept bending moment at maximum design weight for wings fixed or forward at station 1, in.-lb	BLCNTL
46	Unswept bending moment at basic flight design weight for wings forward at station 1, in.-lb	BLCNTL
47	Unswept bending moment at landing design weight for wings forward at station 1, in.-lb	BLCNTL
48	Swept bending moment at maximum design weight for wings forward at station 2, in.-lb	BLCNTL
49	Swept bending moment at basic flight design weight for wings forward at station 2, in.-lb	BLCNTL
50	Swept bending moment at landing design weight for wings forward at station 2, in.-lb	BLCNTL

TABLE 61. XMISC ARRAY VARIABLES (MISC BLOCK) (CONT)

Loc	Description	Subroutine Reference
Locations 51 through 69 contain load module control words; these controls are established in the executive module.		
51	Air vehicle class indicator 1 = fighter (F) 2 = attack (A) 3 = tactical bomber (BI) 4 = strategic bomber (BII) 5 = cargo assault (CA) 6 = cargo transport (CT)	BLCNTL
52	Wing type indicator -1 = fixed wing 1 = variable sweep wing	BLCNTL
53	Vertical tail type indicator -1 = single tail 0 = dual tail 1 = T-type tail	BLCNTL
54	Load calculation option indicator -1 = calculate basic loads only 0 = calculate fatigue spectra only 1 = calculate both loads and fatigue spectra	BLCNTL
Locations 55 through 68 contain basic load calculation control 1 = compute 0 = do not compute		
55	Total vehicle load calculation control 1 = compute all loads (fuselage, wing, horizontal, vertical) 0 = compute loads as indicated by controls in locations 56 through 59	BLCNTL

TABLE 61. XMISC ARRAY VARIABLES (MISC BLOCK) (CONCL)

Loc	Description	Subroutine Reference
56	Fuselage load calculation indicator	BLCNTL
57	Wing load calculation indicator	BLCNTL
58	Horizontal tail load calculation indicator	BLCNTL
59	Vertical tail load calculation indicator	BLCNTL
60	Load conditions 1 through 5 calculation indicator (positive maneuver conditions)	BLCNTL
61	Load conditions 6 and 7 calculation indicator (negative maneuver conditions)	BLCNTL
62	Load condition 8 calculation indicator (flap down maneuver condition)	BLCNTL
63	Load condition 9 calculation indicator (flaps down landing)	BLCNTL
64	Load conditions 10 through 13 calculation indicator (positive vertical gust conditions)	BLCNTL
65	Load conditions 14 through 17 calculation indicator (negative vertical gust conditions)	BLCNTL
66	Load conditions 18 and 19 calculation indicator (lateral gust conditions)	BLCNTL
67	Load conditions 20 and 21 calculation indicator (pitching acceleration conditions)	BLCNTL
68	Load conditions 22 and 23 calculation indicator (yawing acceleration conditions)	BLCNTL
69	Fatigue spectra calculation indicator -1 = compute gust and maneuver spectra 1 = compute gust spectra only	BLCNTL

TABLE 62. IP OR IQ ARRAY VARIABLES (IPRINT BLOCK)

Loc	Description	Figure Reference	Subroutine Reference
1 • 49	Locations 1 through 49 are print controls for other program modules		
50	Output print control of component airloads, CP's, and vehicle inertia factors	B-12	BNLDS
51	Output print control of surface airload shear, bending moment, and torque at load reference stations	B-13, B-14, B-15	SPABM
52	Output print control of loading parameters and unit spanwise loads	B-1 through B-11	USPAN
53	Output print control of wing and empennage design loads envelope and normalizing factors	B-16 through B-21	WHVNET
54	Output print control of maximum net wing bending moments at fatigue reference stations and print control of ambient condition, temperature, material property, and dynamic pressure data	B-22	BLCNTL
55	Output print control of wing bending moment spectra data	B-23, B-24 B-25	FATMG
56 • 80	Locations 56 through 80 are print controls for other program modules		

TABLE 63. MASS STORAGE FILE RECORDS

Record No.	Variables & Length	Write Routine	Read Routines	Description
1	DT(56)	Input Data Processing Module	BLCNTL	Permanent file aerodynamic data; refer to Table 50 for discussion of variables.
2	DB(853)	Input Data Processing Module	BLCNTL	Permanent file subsonic aerodynamic data; refer to Table 26 for discussion of variables.
3	DF(146)	Input Data Processing Module	BLCNTL	Permanent file deflected flap aerodynamic data; refer to Table 35 for discussion of variables.
4	DP(734)	Input Data Processing Module	BLCNTL	Permanent file supersonic aerodynamic data; refer to Table 39 for discussion of variables.
5	DS(288)	Input Data Processing Module	FATMG	Permanent file or input blocked mission segment data; refer to Table 43 for discussion of variables.
6	DE(340)	Input Data Processing Module	FATMG	Permanent file maneuver load factor spectra tables; refer to Table 29 for discussion of variables.
7	DI(60)	Input Data Processing Module	FATMG	Permanent file taxi load factor spectra tables; refer to Table 38 for discussion of variables.

TABLE 63. MASS STORAGE FILE RECORDS (CONT)

Record No.	Variables & Length	Write Routine	Read Routines	Description
8	DG(72)	Input Data Processing Module	FATMG	Permanent file turbulence field parameters; refer to Table 57 for discussion of variables.
9	DR(109)	Input Data Processing Module	FATMG	Permanent file gust response factors; refer to Table 41 for discussion of variables.
17	RATIO (264)	WHVNET		Load factor, temperature, and content normalizing factors; refer to Table 70 for discussion of variables. This record is initialized in the executive module.
18	WLD(300)	Data Management Module	BLCNTL	Structural component normalized inertia load data; refer to Table 59 for discussion of variables.
21	WD(200)	Data Management Module	MAXLDS	Geometry and miscellaneous data.
22	BC(195)	Data Management Module	BLCNTL	Air vehicle design data; refer to Table 23 for discussion of variables.
31	SVF(180)	Flutter and Temperature Module	BLCNTL	Ambient condition, temperature, and structural component material property data; refer to Table 58 for discussion of variables.

TABLE 63. MASS STORAGE FILE RECORDS (CONCL)

Record No.	Variables & Length	Write Routine	Read Routines	Description
32	DUM(198)	WHVNET		Design airload shear and bending moments normalized to reference design temperature; refer to Table 51 for discussion of variables. This record is initialized in the executive module.
33	FUS(672)	FUSNET		Vehicle airloads, CP's, inertia factors, and structure temperature data; refer to Table 72 for discussion of variables.
35	DUMMY (820)	FATMG		Wing bending moment spectra; refer to Tables 75 and 76 is subroutine FATMG discussions.
159	WHVLID (24)	MAXLDS		Load condition number array; Refer to subroutine WHVNET discussion.
160-183	BO(200)	MAXLDS		Vehicle airloads, CP's, inertia factors, and distributed loads data; refer to Table 24

SUBROUTINE DESCRIPTIONS

PROGRAM BLCNTL

General Description

Deck name: BLCNTL
Entry name: OVERLAY (5HALPHA,4,0)
Called by: OLAY00
Subroutines called: USPAN, BNLDS, SPABM, MAXLDS, FUSNET, WINNET, FATMG

This is the control routine for the airload module. This routine initializes the output region of common and reads the following file records.

Array	Record No.	Descriptions
DT	1	Permanent file aerodynamic data
DB	2	Permanent file subsonic aerodynamic data
DF	3	Permanent file deflected flap aerodynamic data
DP	4	Permanent file supersonic aerodynamic data
BC	22	Vehicle design data
SVF	31	Ambient condition, temperature, and structural component material property data
WLD	18	Structural component normalized inertia loads data

Loads module execution controls are obtained through labeled common array XMISC which are transferred into the ND array (Table 64). There are 23 different airload conditions of which as many as 22 may be calculated in a given run. The first level of basic load calculation control indictors (ND(28) - ND(36)) determine the flight conditions, which are to be evaluated. A positive value indicates calculate, and a zero or negative value indicates do not calculate. These controls are used to establish a second level of condition calculation controls (Table 65). Figure 10 shows the speed-altitude points associated, with each of these load conditions. Should basic loads calculation be indicated (ND(16) = - or +) and all values in locations XMISC(60) through XMISC(68) be negative or zero, the corresponding ND locations are all set equal to one.

For each load condition that is to be calculated, this routine:

1. Establishes vehicle design criteria (BB array)

2. Calls subroutine USPAN to calculate the unit spanwise loading distribution and lift curve slope for each of the lifting surfaces

TABLE 64. LOAD MODULE CONTROL INDICATORS

XMISC Array Location	ND Array Location	Description
51	13	Air vehicle class indicator 1 = fighter (F) 2 = attack (A) 3 = tactical bomber (BI) 4 = strategic bomber (BII) 5 = cargo assault (CA) 6 = cargo transport (CT)
52	14	Wing type indicator -1 = fixed wing 1 = variable sweep wing
53	15	Vertical tail type indicator -1 = single tail 0 = dual tail 1 = T-type tail (horizontal tail mounted on vertical tail tip)
54	16	Load calculation option indicator -1 = calculate basic loads only 0 = calculate fatigue spectra only 1 = calculate both basic loads and fatigue spectra
55	23	Basic load calculation option indicator 1 = compute all loads (fuselage, wing, horizontal, vertical) 0 = compute loads as indicated by following controls in ND(24) through ND(27)
56	24	Fuselage load calculation indicator 1 = compute fuselage loads 0 = do not compute fuselage loads

TABLE 64. LOAD MODULE CONTROL INDICATORS (CONT)

XMISC Array Location	ND Array Location	Description
57	25	Wing load calculation indicator 1 = compute wing loads 0 = do not compute wing loads
58	26	Horizontal tail load calculation indicator 1 = compute horizontal tail loads 0 = do not compute horizontal tail loads
59	27	Vertical tail load calculation indicator 1 = compute vertical tail loads 0 = do not compute vertical tail loads
60	28	Load conditions 1 through 5 calculation indicator 1 = compute loads for applicable conditions 0 = do not compute loads
61	29	Load condition 6 and 7 calculation indicator
62	30	Load condition 8 calculation indicator
63	31	Load condition 9 calculation indicator
64	32	Load conditions 10 through 13 calculation indicator
65	33	Load conditions 14 through 17 calculation indicator
66	34	Load conditions 18 and 19 calculation indicator
67	35	Load conditions 20 and 21 calculation indicator

TABLE 64. LOAD MODULE CONTROL INDICATORS (CONCL)

XMISC Array Location	ND Array Location	Description
68	36	Load conditions 22 and 23 calculation indicator
69	39	Fatigue spectra calculation indicator -1 = compute gust and maneuver spectra 1 = compute gust spectra only

TABLE 65. DESIGN LOAD CONDITIONS AND CONSTRAINTS

Load Cond No. (CN)	First-Level Go/no-go Indicator ND Loc	Second-Level Go/no-go Indicator ND Loc	Type of Load Cond	Vehicle Wt	Wing Sweep ΛW	Speed-Altitude Profile (Figure 10) Point	Mach No.	Alt	Additional Design Constraints
1	28	109	$+N_Z$	BFDW	Fix-aft	1	M_L	SL	
2	28	110	$+N_Z$	BFDW	Fix-aft	2	M_L	Int	Only if M_L at $2 \geq M_L$ at 3
3	28	111	$+N_Z$	BFDW	Fix-aft	3	M_L	Min at Max M_H	Only if M_L at $3 > M_L$ at 2
4	28	112	$+N_Z$	BFDW	Fix-aft	7	0.9	SL	Only if M_L at $1 \geq 1.0$
5	28	113	$+N_Z$	BFDW	Fwd	10	M_H	SL	Variable sweep wing only
6	29	114	$-N_Z$	BFDW	Fix-aft	4	M_H	SL	
7	29	115	$-N_Z$	BFDW	Fwd	10	M_H	SL	Variable sweep wing only
8	30	116	Man Flap	MDW	Fix-fwd	8	1.5 V_{SO}	SL	
9	31	117	1g trim	LDW	Fix-fwd	9	1.2 V_{SL}	SL	

TABLE 65. DESIGN LOAD CONDITIONS AND CONSTRAINTS (CONT)

Load Cond No. (CN)	First-Level Go/no-go Indicator ND Loc	Second-Level Go/no-go Indicator ND Loc	Type of Load Cond	Vehicle Wt	Wing Sweep Λ_W	Speed-Altitude Profile (Figure 10)			Additional Design Constraints
						Point	Mach No.	Alt	
10	32	118	+Vert Gust	BFDW	Fix-aft	4	M_H	SL	
11	32	119	+Vert Gust	BFDW	Fix-aft	5	M_H	Int	
12	32	120	+Vert Gust	BFDW	Fwd	10	M_H	SL	Variable sweep wing only
13	32	121	+Vert Gust	BFDW	Fwd	11	M_H	Int	Variable sweep wing only
14	33	122	-Vert Gust	BFDW	Fix-aft	4	M_H	SL	
15	33	123	-Vert Gust	BFDW	Fix-aft	5	M_H	Int	
16	33	124	-Vert Gust	BFDW	Fwd	10	M_H	SL	Variable sweep wing only
17	33	125	-Vert Gust	BFDW	Fwd	11	M_H	SL	Variable sweep wing only
18	34	126	Lat Gust	BFDW	Fix-aft	4	M_H	SL	

TABLE 65. DESIGN LOAD CONDITIONS AND CONSTRAINTS (CONCL)

Load Cond No. (CN)	First-Level Go/no-go Indicator ND Loc	Second-Level Go/no-go Indicator ND Loc	Type of Load Cond	Vehicle Wt	Wing Sweep ΛW	Speed-Altitude Profile (Figure 10)			Additional Design Constraints
						Point	Mach No.	Alt	
19	34	127	Lat Gust	BFDW	Fix-aft	5	M_H	Int	
20	35	128	Pitch Acc	BFDW	Fix-aft	1	M_L	SL	
21	35	129	Pitch Acc	BFDW	Fix-aft	3	M_L	Min at Max M_H	
22	36	130	Yaw Acc	BFDW	Fix-aft	1	M_L	SL	
23	36	131	Yaw Acc	BFDW	Fix-aft	3	M_L	Min at Max M_H	
24	-	-	2g Taxi	MDW	Fix-fwd	-	-		

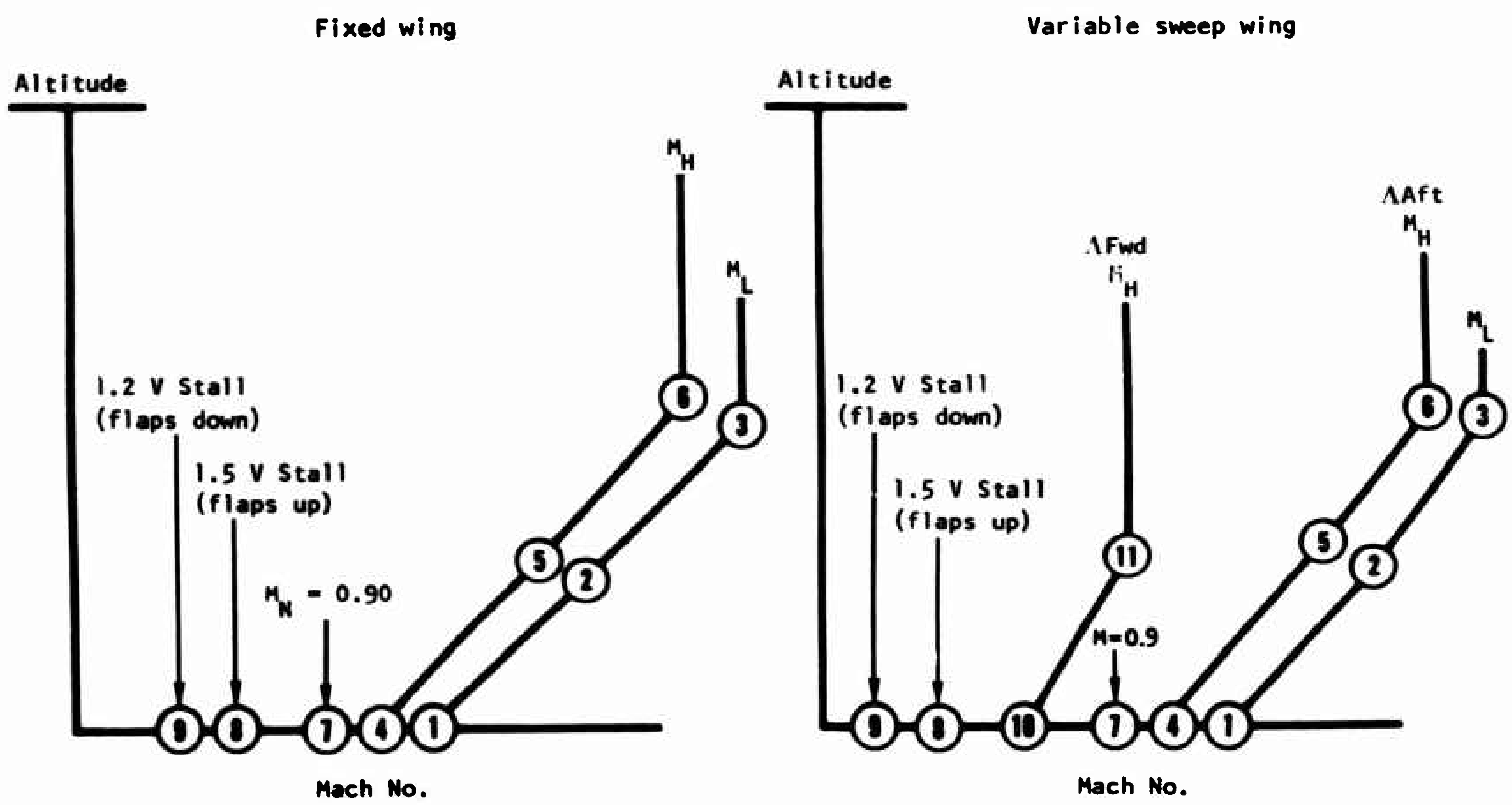


Figure 10. Speed altitude points and flight conditions.

3. Calls subroutine BNLDS to calculate the component gross limit airloads and centers of pressure

4. Calls subroutine SPABM to calculate limit airload shear, bending moment and torque for each surface designated (ND(23), ND(25) - ND(27))

5. Scans wing load data for the maximum net bending moment at the fatigue evaluation stations

6. Calls subroutine MAXLDS to determine the net design load envelope for each of the lifting surfaces

7. Calls subroutine FUSNET to store the specific condition loads data for transmittal to the fuselage weight estimation module

After all designated flight load conditions have been evaluated, MAXLDS is called to evaluate the taxi loads on the wing, and WHVNET is called to organize the design loads data, calculate normalizing factors, and store the data for use by the wing and empennage weight estimating module.

Should wing fatigue spectra data be required (ND(16)), subroutine FATMG is called.

Arrays and Variables Used

BC	Vehicle design data (Table 25)
BO	Vehicle component airload data (Table 24)
PSI	Ambient pressure at load conditions
SFLUX	Sun flux at load conditions
SVF	Ambient condition, temperature, and structural component material property data
TSKINF	Equilibrium structure temperature at load condition, °F
TSKINR	Equilibrium structure temperature at load conditions, °R
TTOTAL	Total temperature at load conditions, °R

Arrays and Variables Calculated

ALT	Vehicle altitude at load condition
BB	Vehicle design criteria at load condition
BO	Vehicle and component identification codes

I	Load condition number counter
IDUM	Design load condition numbers for net surface loads envelope
IN	Load calculation control; 0 = do all, 1 = do as indicated
ND	Basic loads calculation controls and indicators
NF	Control to direct USPAN to calculate unit load distributions for all surfaces (-1)
NI	Load condition category indicator 1 = Flaps up balanced maneuver 2 = Flaps down balanced maneuver 3 = Flaps down balanced maneuver 4 = Positive vertical gust 5 = Negative vertical gust 6 = Lateral gust 7 = Pitch acceleration 8 = Yaw acceleration
RC	Ratios of wing content inertia loads per g at load condition to inertia load per g at basic flight design weight
RNZ	Ratio of load factor at design condition to reference load factor
SAVE	Design airload shear and bending moment envelope
STEMPH	Horizontal tail material compression yield strength at design condition structure temperature
STEMPV	Vertical tail material compression yield strength at design condition structure temperature
STEMPW	Wing material compression yield strength at design condition structure condition structure temperature
WLD	Structural component inertia loads per g and wing net taxi loads data
XMACH	Vehicle mach number at load conditions
XNET	Net design loads array normalized to room temperature reference.

Scratch Arrays and Variables (Program Region)

BMDWT1	Unswept inertia bending moment per g at maximum BMNET1 for wing fatigue evaluation station 1
BMDWT2	Swept inertia bending moment per g at maximum BMNET2 for wing fatigue evaluation station 2
BMDW1	Unswept inertia bending moment per g at wing station 1
BMDW2	Swept inertia bending moment per g at wing station 2
BMNET1	Net unswept bending moment at wing station 1
BMNET2	Net swept bending moment at wing station 2
BM1	Unswept airload bending moment at wing station 1
BM2	Swept airload bending moment at wing station 2
ENZ1	Vehicle load factor at maximum BMNET1
ENZ2	Vehicle load factor at maximum BMNET2
IBM1	Condition number at maximum BMNET1
IBM2	Condition number at maximum BMNET2
IH	Horizontal tail reference design load condition
IV	Vertical tail reference design load condition
IW	Wing reference design load condition
N	Scratch counter
THT	Horizontal tail structure temperature at reference design load condition, °F
TVT	Vertical tail structure temperature at reference design load condition, °F
TWING	Wing structure temperature at reference design load condition, °F

Labeled Common Arrays

IP(54)	0 = Print output of maximum net design bending moments at wing side of fuselage (unswept) and outboard station (swept) for fatigue evaluation
	1 = Do not print
XMISC(32)	Maximum net unswept bending moment at wing side of fuselage station (station 1)
XMISC(33)	Maximum net swept bending moment at wing outboard station (station 2)
XMISC(43)	Unswept inertia bending moment per g at basic flight design weight for wings fixed for aft at wing station 1
XMISC(45)	Unswept inertia bending moment per g at maximum design weight for wings fixed or forward at wing station 1
XMISC(46)	Unswept inertia bending moment per g at basic flight design weight for wings forward at station 1
XMISC(47)	Unswept inertia bending moment per g at landing design weight for wings forward at station 1
XMISC(48)	Swept inertia bending moment per g at maximum design weight for wings forward at station 2
XMISC(49)	Swept inertia bending moment per g at basic flight design weight for wings forward at station 2
XMISC(50)	Swept inertia bending moment per g at landing design weight for wings forward at station 2
XMISC(51) to XMISC(69)	Refer to Table 64.

Mass Storage File Records

Records 1 to 4, 18, 22, 31,

Error Messages

None

SUBROUTINE USPAN

General Description

Deck name: USPAN
Entry name: USPAN
Called by: BLCNTL, FATMG
Subroutines called: None
Function reoutines called: CODIM2, FCODM2

This subroutine uses the aerodynamic data tables and performs the calculations to obtain:

1. Unit airload shear, bending moment, and torque on the lifting surfaces.

2. Center of pressure locations

3. Lift curve slopes

Function routines CODIM2 and FCODM2 are used to obtain curve fit interpolated values from the aerodynamic data tables. This subroutine uses the basic aerodynamic data table (DT) with either the subsonic aerodynamic data table (DP) to obtain the loading parameters for the basic lifting surfaces. For deflected flap conditions, the DF table is used to obtain flap loading parameters.

The mach number parameter, B, is defined as:

1. Subsonic: $B = \sqrt{1-M^2}$

2. Supersonic: $B = \sqrt{M^2-1}$

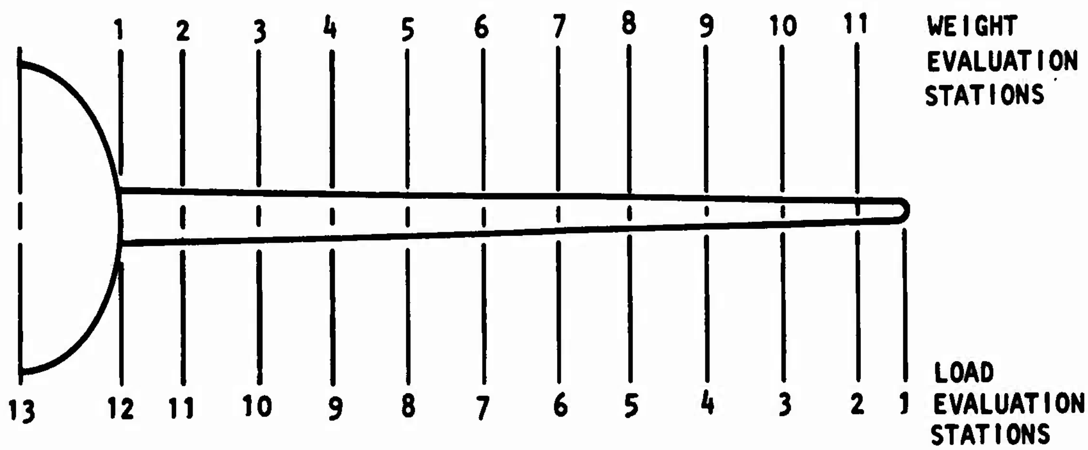
When vehicle speed is close to mach 1, this parameter approaches zero such that table parameters cannot be evaluated. In order to circumvent this situation, the following rule is applied:

If $1.0 > M > 0.95$ $M = 0.95$

If $1.1 > M \geq 1.0$ $M = 1.1$

USPAN is called by either BLCNTL or FATMG. When called by BLCNTL, airloading distributions are calculated for all lifting surfaces (wing, horizontal, and vertical). The control word NF has a preassigned value of -1. When this routine is called by FATMG, NF is equal to +1 designating the calculation of flaps up wing spanwise loading distributions only.

The range of weight evaluation stations do not necessarily encompass the total lifting surface which is required in the loading calculations. The following sketch depicts the orientation of the load evaluation stations relative to the weight evaluation stations.



<u>Arrays and Variables Used</u>

BB	Vehicle design criteria at load condition
BC	Vehicle design data
CMN	Vehicle mach number at load condition (BB(10))
DB	Permanent file subsonic aerodynamic data
DF	Permanent file deflected flap aerodynamic data
DP	Permanent file supersonic aerodynamic data
DT	Permanent file aerodynamic data
ND	Basic load calculation controls and indicators

NF Control to direct calculation

-1 = calculate distribution for all surfaces
1 = calculate distribution for wing only

VT Vertical tail identification

5 = single tail
6 = dual tail
7 = T-type tail

Arrays and Variables Calculated

BB Surface center of pressure data

BU Unit spanwise loading, lift curve slope, and center-of-pressure data

IP Wing type and position indicator

-1 = fixed wing
0 = variable sweep wing, forward position
1 = variable sweep wing, aft position

Scratch Arrays and Variables

BD Spanwise loading parameters, refer to Table 66

BS Refer to Table 67

DX Normal distance from load reference to local center of pressure (BD)

ED Normalized spanwise stations for tabulated data (BD)

ES Normalized spanwise stations for load evaluation (BD)

I Scratch counter

J Scratch counter

K Scratch counter

L Scratch counter

M Scratch counter

NT	Surface indicator
YA	Subsonic lift curve slope parameter
YB	Spanwise loading parameter
YC	Spanwise loading parameter
YS	Unitized spanwise loading parameter

Labeled Common Arrays

IQ(52)	0 = Print output of loading parameters and unit spanwise loads 1 = Do not print

Mass Storage File Records

None

Error Messages

None

TABLE 66. BD ARRAY VARIABLES IN SUBROUTINE USPAN

Loc	Variable Name	Engrg Symbol	Description
1	YA(1)	$BC_{L\alpha}/K$	Subsonic lift curve slope parameter at taper ratio = 0 (λ_1 in DT array)
.	.		To
4	YA(4)	$BC_{L\alpha}/K$	Subsonic lift curve slope parameter at taper ratio = 1.0 (λ_4 in DT array)
5	YA(5)		Not used
6	YB(1)	$C_\ell C/C_L C_{AV}$	Subsonic spanwise loading parameter at taper ratio = 0, percent span = 0 (λ_1 and η_1 in DT array)
		$\Gamma/V\alpha b/2$	Supersonic spanwise loading parameter at taper ratio = 0, percent span = 0
		$C_\ell C/C_L C_{AV}$	Deflected flap spanwise loading parameter at load evaluation station 1 for flap span from centerline to inboard flap station
.		.	To
18	YB(13)	$C_\ell C/C_L C_{AV}$	Subsonic spanwise loading parameter at taper ratio = 0, percent span = 0.924 (λ_1 and η_4 in DT array)
		$\Gamma/V_\alpha b/2$	Supersonic spanwise loading parameter at taper ratio = 0, percent span = 0.924
		$C_\ell C/C_L C_{AV}$	Deflected flap spanwise loading parameter at load evaluation station 13 for flap span from centerline to inboard flap station
.		.	To
21	YB(16)	$C_\ell C/C_L C_{AV}$	Subsonic spanwise loading parameter at taper ratio = 1, percent span = 0.924 (λ_4 and η_4 in DT array)
		$\Gamma/V_\alpha b/2$	Supersonic spanwise loading parameter at taper ratio = 1, percent span = 0.924

TABLE 66. BD ARRAY VARIABLES IN SUBROUTINE USPAN (CONT)

Loc	Variable Name	Engrg Symbol	Description
22	YB(17)		Not used
.			To
25	YB(20)		Not used
26	YC(1)	$C_{\ell}C/C_L C_{AV}$ or, $\Gamma/V_{\alpha}b/2$	Spanwise loading parameter at percent span = 0 (η_1 in DT array)
.	.		To
29	YC(4)	$C_{\ell}C/C_L C_{AV}$ or, $\Gamma/V_{\alpha}b/2$	Spanwise loading parameter at percent span = .924 (η_4 in DT array)
30	YC(5)	$C_{\ell}C/C_L C_{AV}$ or, $\Gamma/V_{\alpha}b/2$	Spanwise loading parameter at percent span = 1.0 (value is 0.0)
31	ED(1)	1	Percent span for YC(1)
.		.	To
35	ED(5)	5	Percent span for YC(5)
36	ES(1)	S1	Percent span at load evaluation station 1 (tip station)
.	.	.	To
48	ES(13)	η_{S13}	Percent span at load evaluation station 13 (root station)
49	ES(14)		Not used
50	ES(15)		Not used
51	YS(1)		Interpolated or unitized spanwise loading parameter at η_{S1} (tip)
.	.		To
63	YS(13)		Interpolated or unitized spanwise loading parameter at η_{S13} (root)
64	YS(14)		Not used
65	YS(15)		Not used

TABLE 66. BD ARRAY VARIABLES IN SUBROUTINE USPAN (CONCL)

Loc	Variable Name	Engrg Symbol	Description
66	DX(1)	$\Delta X\Lambda_1$	Normal distance from load reference to the local CP at station η_{S1} (tip)
.	.	.	To
78	DX(13)	$\Delta X\Lambda_{13}$	Normal distance from load reference to the local CP at station η_{S13} (root)
79	DX(14)		Not used
80	DX(15)		Not used
81			Not used
.			To
88			Not used
89			Surface carryover lift reduction factor
90			Total summated surface lift per side unreduced for carry-over lift loss
91			Not used
.			To
160			Not used

TABLE 67. BS ARRAY VARIABLES IN SUBROUTINE USPAN

Loc	Engrg Symbol	Description
1	A	Aspect ratio
2	ΛB	Compressible sweep parameter, deg
3	λ	Taper ratio
4	Λ_{LE}	Sweep of the leading edge, deg
5	B/K	Compressible lift curve slope correction factor
6	BA/K	Aspect ratio parameter (subsonic)
7	BA	Aspect ratio parameter (supersonic)
8	Bm	Sweep parameter (supersonic)
9		Summation of distributed lift from root to tip
10	(X/C)cp	Section center of pressure to chord ratio due to mach number
11	C_R	Root section chord (apex chord), in
12	b/2	Surface semispan, in.
13	Y_B	Body half width (surface-body interface), in.
14	η_B	Fraction of semispan at surface-body interface
15	$Y_{FO}/b/2$	Outboard flap station to wing semispan ratio
16	$Y_{FI}/b/2$	Inboard flap station to wing semispan ratio
17	M	Mach number at load condition
18	K_Λ	Sweep correction factor calculations
19	$(X_\Lambda/C_\Lambda)_R$	Swept reference chord to section chord ratio
20	$C_{\Lambda B}$	Swept chord at body-surface interface

SUBROUTINE BNLDS

General Description

Deck name: BNLDS
Entry name: BNLDS
Called by: BLCNTL
Subroutines called: ATMOS
Function routines called: CODIM2

This subroutine calculates the component gross limit airloads and centers of pressure for the different flight conditions. Function routine ATMOS is used to obtain the density of air and the speed of sound at the altitude for the specific flight condition. Dynamic pressure and equivalent airspeed is calculated from this data

$$q = 1/2\ \rho V_e^2 = 1/2\ \rho M^2\ C_S^{\ 2},\ \text{lb/ft}^2$$

where:

ρ = density of air, slugs/ft^3

M = vehicle mach number

C_S = speed of sound, ft/sec^2

$$V_e = \sqrt{295q},\ \text{knots}$$

Methods described in Section II of this report are used to calculate component loads for:

1. Balanced maneuver conditions
2. Vertical gust conditions
3. Lateral gust conditions
4. Pitching acceleration conditions
5. Yawing acceleration conditions

The different types of load conditions are designated by the control word NI. Specific definition of NI is as follows:

NI Value	Load Condition No.	Description
1	1 - 7	Flaps-up balanced maneuver
2	8	Flaps-down balanced maneuver
3	9	Flaps-down balanced maneuver
4	10 - 13	Positive vertical gust
5	14 - 17	Negative vertical gust
6	18 - 19	Lateral gust
7	20 - 21	Pitching acceleration
8	22 - 23	Yawing acceleration

Arrays and Variables Used

BB Vehicle design criteria and center-of-pressure data at load condition

BC Vehicle design data

BO Load condition identification number

BU Unit spanwise loading, lift curve slope, and center of pressure data

DF Permanent file deflected flap aerodynamic data

IP Wing, type and position indicator

-1 = fixed wing
0 = variable sweep wing, forward position
1 = variable sweep wing, aft position

ND Basic load calculation controls and indicators

NI Load condition type indicator

Arrays and Variables Calculated

BO Component airloads, centers of pressure, and vehicle load factor and accelerations

BU Exposed wing and horizontal tail loads

Scratch Arrays and Variables

BD Initial component load estimates, refer to Table 68

BS Refer to Table 69

I Scratch counter

J Scratch counter

K Scratch counter

NT Surface indicator

Labeled Common Arrays

IQ(50) 0 = Print output of component airloads, centers of pressure, and vehicle inertia factors

1 = Do not print

Mass Storage File Records

None

Error Messages

None

TABLE 68. BD ARRAY VARIABLES IN SUBROUTINE BNLDS

Loc	Engrg Symbol	Description
1	P_{ZNO}	Initial estimate of nose lift
2	$P_{ZW(B)O}$	Initial estimate of wing lift in presence of body due to angle of attack
3	$P_{ZB(W)O}$	Initial estimate of body lift in presence of wing due to angle of attack
4	P_{ZHO}	Initial estimate of horizontal tail lift
5	$P_{ZW(B)FO}$	Initial estimate of wing lift in presence of body due to deflected flaps
6	$P_{ZB(W)FO}$	Initial estimate of wing lift in presence of body due to deflected flaps
7	ΔP_{ZNG}	Incremental nose lift due to gust
8	$\Delta P_{ZW(B)G}$	Incremental wing lift in presence of body due to gust
9	$\Delta P_{ZB(W)G}$	Incremental body lift in presence of body due to gust
10	ΔP_{ZHG}	Incremental horizontal tail lift due to gust
11		Not used
•		To
160		Not used

TABLE 69. BS ARRAY VARIABLES IN SUBROUTINE BNLDS

Loc	Engrg Symbol	Description
1	ρ	Density of air at load condition altitude, slugs/ft^3
2	P_H	Ambient pressure at load condition altitude, psi
3	C_S	Speed of sound at load condition altitude, ft/sec
4	q	Dynamic pressure, lb/ft^2
5	Ve	Equivalent airspeed, knots
6	$\overline{X}_{W(B)f}$	Center of pressure for flap increment on wing in presence of body, in.
7	$\overline{X}_{B(W)f}$	Center of pressure for flap increment on body in presence of wing, in.
8	C_{LWO}	Initial wing lift coefficient estimate
9	ΔC_{Lf}	Initial wing lift coefficient due to flap deflection estimate
10	Nz	Vehicle vertical load factor
11	α_O	Initial estimate of vehicle angle of attack, radians
12	ΣP_{ZO}	Summation of initial estimated vehicle component lift loads
13	ΔP_{ZH}	Incremental horizontal tail load required to produce specified pitch acceleration
14	μ	Vehicle mass ratio
15	kg	Gust alleviation factor
16		Ratio of required airload to estimated total airload
17 . 20		Not used To Not used

SUBROUTINE SPABM

General Description

Deck name: SPABM
Entry name: SPABM
Called by: BLCNTL
Subroutines called: None

This subroutine calculates the limit airload shear, bending moment, and torsion along the load reference line for each of the lifting surface. Limit loads are obtained by multiplying the surface air loads calculated in BNLDS by the unit spanwise distributions calculated in USPAN. The counter ID is used to designate the surface and type of calculation involved.

ID Value	Load and Surface Designation
1	Basic wing loads
2	Wing loads due to deflected flaps
3	Horizontal tail loads
4	Dual vertical tail
5	Single vertical tail
6	T-type vertical tail (horizontal mounted on vertical tail tip)

Wing load calculations assume half the total lift on each panel. Limit loads are obtained by combining the basic wing load contribution with the deflected flap contribution.

For the horizontal tail, an unsymmetrical loading[12] of 15 percent greater than half the total surface load is used to calculate panel design airload shear bending moment and torque.

Vertical tail load calculations are dependent on the type of surface. For dual tails, 55 percent of the total airload is used to calculate panel design airload shear, bending moment, and torque.

On T-type tails the unsymmetrical horizontal tail moment contribution is combined with the vertical tail airload shear, bending moment, and torque.

For a single vertical tail, the relative position of the horizontal tail is checked to determine whether the unsymmetrical horizontal tail moment acts at any vertical tail load evaluation station.

Arrays and Variables Used

BB	Vehicle design criteria and center-of-pressure data at load condition
BC	Vehicle design data
BO	Component airloads, centers of pressure, and vehicle inertia factors
BU	Unit spanwise loading, lift curve slope, and center of pressure data
IP	Wing type and position indicator -1 = fixed wing 0 = variable sweep wing, forward position 1 = variable sweep wing, aft position
ND	Basic loads calculation controls and indicators

Arrays and Variables Calculated

BO	Component spanwise swept stations and airload shear, bending moment, and torque

Scratch Arrays and Variables

BS(1)	Surface airload per panel for scaling unit spanwise loads, lb
BS(2)	Surface semispan (span of vertical tail), in.
BS(3)	Sweep of surface load reference axis, degrees
BS(5)	Horizontal tail unsymmetrical moment contribution to vertical tail loads. 0 = no effect 1.0 = add unsymmetrical moment
BS(6)	Swept distance from vertical tail root to horizontal tail plane
I	Scratch counter
ID	Surface indicator

J	Scratch counter
K	Scratch counter
L	Scratch counter
M	Scratch counter
V1	Cosine of surface load reference axis sweep
V2	Sine of surface load reference axis sweep

Labeled Common Arrays

IQ(51)	0 = Print output of surface airload shear, bending moment, and torque at load reference stations 1 = Do not print

Mass Storage File Records

None

Error Messages

None

SUBROUTINE MAXLDS

General Description

Deck name: MAXLDS
Entry name: MAXLDS
Called by: BLCNTL
Subroutines called: None

This subroutine calculates net loads by combining airloads and inertia loads. Loads are normalized for temperature by applying the structure material compression yield stress ratio to the calculated net loads. Comparative tests between previously calculated net loads envelope data with net loads for the specific loads condition is used to determine the design loads envelope. Net loads envelopes are determined for the wing, horizontal tail and vertical tail by evaluating all flight conditions. Wing net taxi loads are also examined to determine whether the taxi condition is critical. Should taxi define part of the wing load envelope, the net loads are saved as fictitious airload, and the inertia load factor ratio is set to zero.

This routine writes the component airload data (BO array) into records 160 to 183.

Arrays and Variables Used

BB	Vehicle design criteria at load condition
BC	Vehicle design data
BMH	Horizontal tail and content 1 g inertia bending moment
BMV	Vertical tail and content 1 g inertia bending moment
BMW2	Wing only 1 g inertia bending moment (wing fixed or forward)
BM12	Wing and content 1 g inertia bending moment at BFDW (wing fixed or aft)
BM2G	Wing net bending moment at 2 g taxi at MDW (wing fixed or forward)
BM21	Wing and content 1 g inertia bending moment at MDW (wing fixed or forward)
BM22	Wing and content 1 g inertia bending moment at BFDW (wing fixed or forward)

BM23	Wing and content 1 g inertia bending moment at LDW (wing fixed or forward)
BO	Vehicle component airload, centers of pressure, and inertia factors
I	Load condition number counter
ND	Basic load calculation controls and indicators
NHOR	Number of values in the horizontal tail stress, G, temperature tables
NVER	Number of values in the vertical tail stress, G, temperature tables
NWING	Number of values in the wing stress, G, temperature tables
POSNZ	Maximum positive maneuver load factor
STH	Horizontal tail material compression yield strength at material library temperatures
STV	Vertical tail material compression yield strength at material library temperatures
STW	Wing material compression yield strength at material library temperatures
SVF	Ambient condition, temperature, and structural component material property data array
S80H	Horizontal tail material compression yield strength at 80° F
S80V	Vertical tail material compression yield strength at 80° F
S80W	Wing material compression yield strength at 80° F
TEMPH	Horizontal tail material temperature for library values of compression yield strength and shear modulus
TEMPV	Vertical tail material temperature for library values of compression yield strength and shear modulus

TEMPW	Wing material temperature for library values of compression yield strength and shear modulus
TSKINF	Equilibrium structure temperature at load conditions
T2G	Wing net torque at 2 g taxi at MDW (wing fixed or forward)
VH	Horizontal tail and content 1 g inertia shear
VV	Vertical tail and content 1 g inertia shear
VW2	Wing only 1 g inertia shear (wing fixed or forward)
V12	Wing and content 1 g inertia shear at BFDW (wing fixed or aft)
V2G	Wing net shear at 2 g taxi at MDW (wing fixed or forward)
V21	Wing and content 1 g inertia shear at MDW (wing fixed or forward)
V22	Wing and content 1 g inertia shear at BFDW (wing fixed or forward)
V23	Wing and content 1 g inertia shear at LDW (wing fixed or forward)
WLD	Structural component normalized inertia loads array.
XNEGNZ	Maximum negative maneuver load factor

Arrays and Variables Calculated

IDUM	Net design load condition indicators
RC	Wing content normalizing factors
RNZ	Load factor normalizing factors
SAVE	Design airload shears and bending moments
SAVET	Design airload torques
STEMPH	Horizontal tail compression yield strength at load condition equilibrium structure temperature
STEMPV	Vertical tail compression yield strength at load condition equilibrium structure temperature

STEMPW Wing compression yield strength at load condition equilibrium structure temperature

XNET Net design loads array normalized to room temperature reference

Scratch Arrays and Variables

BNET Net bending moment normalized to room temperature reference

BWPC Wing and content 1 g inertia bending moment at load condition

HTNZ Local vertical load factor at horizontal tail CG

III Scratch counter

IND Wing position and vehicle weight indicator

1 = wings fixed or forward at BFDW (reference)
0 = all other conditions

J Scratch counter

K Scratch counter

L1 Scratch counter

L2 Scratch counter

M Scratch counter

N Scratch counter

NTEMP Number of values in stress-G-temperature tables

RSH Ratio of horizontal tail material strength at room temperature to strength at load condition

RSV Ratio of vertical tail material strength at room temperature to strength at load condition

RSW Ratio of wing material strength at room temperature to strength at load condition

STRESS	Material compression yield strength at material library temperatures
STREST	Interpolated material compression yield strength at load condition structure temperature
TEMP	Material temperature for library values of compression yield strength and shear modulus
VNET	Net shear normalized to room temperature reference
VTNY	Local lateral load factor at vertical tail CG
VWPC	Wing and content 1 g inertia bending moment at load condition
WD(103)	Total fuel at maximum design weight, lb
WD(104)	Incremental fuel expended from maximum design weight to basic flight design weight, lb
WD(105)	Incremental payload expended form maximum design weight to basic flight design weight, lb
WHVLID	Indicator for each of the load conditions examined
XCG	Vehicle CG at load condition
XCGHT	CG of horizontal tail and contents
XCGVT	CG of vertical tail and contents

Labeled Common Arrays

XMISC(15)	Wing structure material identification number
XMISC(19)	Horizontal tail structure material identification number
XMISC(23)	Vertical tail structure material identification number

Mass Storage File Records

Records 21, 159-183

Error Messages

None

SUBROUTINE WHVNET

General Description

Deck name: WHVNET
Entry name: WHVNET
Called by: BLCNTL
Subroutines called: None

This subroutine organizes the net loads envelope data, calculates normalizing factors, and stores the data for use by the wing and empennage weight estimating module.

Since lifting surface evaluation assumes that the positive net shear and bending moment are larger than the negative loads, horizontal tail airloads are reversed when the net negative bending moment at the root weight analysis station is greater than the net positive bending moment. When the loads are reversed, an indicator is placed in XMISC(42). When this indicator is not zero, the reference positive and negative load factors are reversed in the weight estimating module calculations.

The routine uses the structure temperature associated with the load condition which results in the design net positive bending moment at the surface root weight evaluation station as a reference. This reference temperature is used to determine strength normalizing factors for the surface loads envelope.

Arrays and Variables Used

IDUM	Net design load condition indicators
ND	Basic load calculation controls and indicators
RC	Wing content normalizing factors
RNZ	Load factor normalizing factors
SAVE	Design airload shears and bending moments
SAVET	Design airload torques
STEMPH	Horizontal tail material compression yield strength at load condition equilibrium structure temperature
STEMPV	Vertical tail material compression yield strength at load condition equilibrium structure temperature

STEMPW	Wing material compression yield strength at load condition equilibrium structure temperature
SVF	Ambient condition, temperature, and structural component material property data array
S80W	Wing material compression yield strength at 80° F
TSKINF	Equilibrium structure temperature at load conditions
XNET	Net design load array normalized to room temperature reference

Arrays and Variables Calculated

DUM	Design airload shears and bending moments normalized to reference design temperature
RATIO	Load factor, temperature, and content normalizing factors; refer to Table 70
RS	Temperature normalizing factors; refer to Table 71

Scratch Arrays and Variables

IDBM	Intermediate storage for horizontal tail design bending moment load condition number
IDSH	Intermediate storage for horizontal tail design shear load condition
IH	Load condition number that produces design positive bending moment at horizontal tail root weight analysis station
II	Intermediate storage of design load condition numbers
IND	Indicator to designate region in DUM array to be cleared
IV	Load condition number that produces design positive bending moment at vertical tail root weight analysis station
IW	Load condition number that produces design positive bending moment at wing root weight analysis station
L1	Scratch counter
L2	Scratch counter

N	Scratch counter
RATIOS	Intermediate storage of horizontal tail normalizing factors
RNZSAV	Intermediate storage of horizontal tail load factor normalizing factors
RSSAV	Intermediate storage of horizontal tail temperature normalizing factors
SAVEBM	Intermediate storage of horizontal tail airload bending moments
SAVESH	Intermediate storage of horizontal tail airload shears
SAVESV	Intermediate storage of horizontal tail airload shears and bending moments
SAVETM	Intermediate storage of horizontal tail airload torques
STRH	Horizontal tail material compression yield strength at reference design temperature
STRV	Vertical tail material compression yield strength at reference design temperature
STRW	Wing material compression yield strength at reference design temperature
THT	Horizontal tail structure temperature (reference temperature) at load condition that produces design positive bending moment at root weight analysis station
TVT	Vertical tail structure temperature (reference temperature) at load condition that produces design positive bending moment at root weight analysis station
TWING	Wing structure temperature (reference temperature) at load condition that produces design positive bending moment at root weight analysis station

<u>Labeled Common</u>

IP(53)	0 = Print output of design loads envelope and normalizing factors 1 = Do not print

XMISC(8)	Wing design temperature (reference temperature)
XMISC(9)	Horizontal tail design temperature (reference temperature)
XMISC(10)	Vertical tail design temperature (reference temperature)
XMISC(15)	Wing structure material identification number
XMISC(19)	Horizontal tail structure material identification number
XMISC(23)	Vertical tail structure material identification number
XMISC(42)	Indicator to designate that horizontal tail loads data have been reversed 0 = Loads have not been reversed 1 = Loads have been reversed

Mass Storage File Records

Records 17 and 32

Error Messages

None

TABLE 70. RATIO ARRAY VARIABLES

Loc	Description
1-11	Load factor ratio times temperature correction ratio at design net positive shear for wing weight analysis stations 11 to 1
12-22	Load factor times temperature correction ratio at design net negative shear for wing weight analysis stations 11 to 1
23-33	Load factor ratio times temperature correction ratio at design net positive bending moment for wing weight analysis stations 11 to 1
34-44	Load factor ratio times temperature correction ratio at design net negative bending moment for wing weight analysis stations 11 to 1
45-55	Load factor ratio times temperature correction ratio at design net positive shear for horizontal tail weight analysis stations 11 to 1
56-66	Load factor ratio times temperature correction ratio at design net negative shear for horizontal tail weight analysis stations 11 to 1
67-77	Load factor ratio times temperature correction ratio at design net positive bending moment for horizontal tail weight analysis stations 11 to 1
78-88	Load factor ratio times temperature correction ratio at design net negative bending moment for horizontal tail weight analysis stations 11 to 1
88-99	Load factor ratio times temperature correction ratio at design net positive shear for vertical tail weight analysis stations 11 to 1
100-110	Load factor ratio times temperature correction ratio at design net negative shear for vertical tail weight analysis stations 11 to 1

TABLE 70. RATIO ARRAY VARIABLES (CONT)

Loc	Description
111-121	Load factor ratio times temperature correction ratio at design net positive bending moment for vertical tail weight analysis stations 11 to 1
122-132	Load factor ratio times temperature correction ratio at design net negative bending moment for vertical tail weight analysis stations 11 to 1
133-143	Load factor ratio times temperature correction ratio times content ratio at design net positive shear for wing weight analysis stations 11 to 1
144-154	Load factor ratio times temperature correction ratio times content ratio at design net negative shear for wing weight analysis stations 11 to 1
155-165	Load factor ratio times temperature correction ratio times content ratio at design net positive bending moment for wing weight analysis stations 11 to 1
166-176	Load factor ratio times temperature, correction ratio times content ratio at design net negative bending moment for wing weight analysis stations 11 to 1
177-187	Load factor ratio times temperature correction ratio at design net torque associated with positive bending moment for wing weight analysis stations 11 to 1
188-198	Load factor ratio times temperature correction ratio at design net torque associated with negative bending moment for wing weight analysis stations 11 to 1
199-209	Load factor ratio times temperature correction ratio at design net torque associated with positive bending moment for horizontal tail weight analysis stations 11 to 1

TABLE 70. RATIO ARRAY VARIABLES (CONCL)

Loc	Description
210-220	Load factor ratio times temperature correction ratio at design net torque associated with negative bending moment for horizontal tail weight analysis stations 11 to 1
221-231	Load factor ratio times temperature correction ratio at design net torque associated with positive bending moment for vertical tail weight analysis stations 11 to 1
232-242	Load factor ratio times temperature correction ratio at design net torque associated with negative bending moment for vertical tail weight analysis stations 11 to 1
243-254	Load factor ratio times temperature correction ratio times content ratio at design net torque associated with positive bending moment for wing weight analysis stations 11 to 1
254-264	Load factor ratio times temperature correction ratio times content ratio at design net torque associated with negative bending moment for wing weight analysis stations 11 to 1

TABLE 71. RS ARRAY VARIABLES

Loc	Description
1-11	Temperature correction ratio at positive design shear for wing weight analysis stations 11 to 1
12-22	Temperature correction ratio at negative design shear for wing weight analysis stations 11 to 1
23-33	Temperature correction ratio at positive design bending moment for wing weight analysis stations 11 to 1
34-44	Temperature correction ratio at negative design bending moment for wing weight analysis stations 11 to 1
45-55	Temperature correction ratio at positive design shear for horizontal tail weight analysis stations 11 to 1
56-66	Temperature correction ratio at negative design shear for horizontal tail weight analysis stations 11 to 1
67-77	Temperature correction ratio at positive design bending moment for horizontal tail weight analysis stations 11 to 1
78-88	Temperature correction ratio at negative design bending moment for horizontal tail weight analysis stations 11 to 1
89-99	Temperature correction ratio at positive design shear for vertical tail weight analysis stations 11 to 1
100-110	Temperature correction ratio at negative design shear for vertical tail weight analysis stations 11 to 1

TABLE 71. RS ARRAY VARIABLES (CONCL)

Loc	Description
111-121	Temperature correction ratio at positive design bending moment for vertical tail weight analysis stations 11 to 1
122-132	Temperature correction ratio at negative design bending moment for vertical tail weight analysis stations 11 to 1

SUBROUTINE FUSNET

General Description

Deck name: FUSNET
Entry name: FUSNET
Called by: BLCNTL
Subroutines called: None

This subroutine is called for each of the flight conditions and for the 2 g taxi condition to organize the airload data required by the fuselage weight estimation module. The reorganized data is stored in mass storage file record 33 after the completion of all load condition calculations.

Arrays and Variables Used

BB	Vehicle design criteria and center-of-pressure data at load condition
BC	Vehicle design data
BO	Component airloads, centers of pressure, and vehicle load factor and accelerations
ND	Basic load condition calculation controls
SVF	Ambient condition, temperature, and structural component material property data array.
TSKINF	Equilibrium structure temperature at load conditions
I	Load condition number counter

Arrays and Variables Calculated

FUS	Vehicle load, centers of pressure, load factor, accelerations, and structure temperature array (refer to Table 72).

Scratch Arrays and Variables

J	Scratch counter
K	Scratch counter
KK	Scratch counter
N	Scratch counter

Labeled Common Arrays

XMISC(35)	Vehicle sink speed at landing condition (I=9)
XMISC(36)	Main landing gear stroke
XMISC(37)	Ratio of ultimate to limit loads
XMISC(38)	Taxi load factor (2.0 g) at taxi condition (I=24)

Mass Storage File Records

Record 33

Error Messages

None

TABLE 72. FUS ARRAY VARIABLES

Location	Description
1	Load condition input data indicator (LDT): • 0.0 or blank if condition is not investigated • 2.0 if condition is to be evaluated and locations • 2 through 28 are defined
2	Load condition type indicator (LDC) 1.0 - balanced flight with flaps up 2.0 - balanced flight with flaps down 3.0 - two-wheeled landing 4.0 - vertical gust 5.0 - lateral gust 6.0 - pitching acceleration 7.0 - yawing acceleration 8.0 - taxi
3-4	Not used
5	Temperature
6	Factor to convert limit load to ultimate load.
7	Vertical load factor
8	Lateral load factor
9	Wing leading edge apex at centerline of fuselage
10	Pitching acceleration
11	Yawing acceleration
12	Vehicle sink speed
13	Landing gear stroke
14	Vehicle velocity

TABLE 72. FUS ARRAY VARIABLES (CONT)

Location	Description
15	Altitude
16	Forebody limit lift
17	Center of pressure of forebody lift - longitudinal station
18	Wing carryover limit lift
19	Center of pressure of carryover lift - longitudinal station
20	Wing outer panel limit lift
21	Center of pressure of wing lift - longitudinal station
22	Center of pressure of wing lift - lateral station
23	Horizontal tail limit lift
24	Center of pressure of horizontal tail lift - longitudinal station
25	Center of pressure of horizontal tail lift - lateral station
26	Vertical tail limit lift
27	Center of pressure of vertical tail lift - longitudinal station
28	Center of pressure of vertical tail lift - lateral station
29-56	Load data for condition 2. Data are organized in the same sequence as noted for locations 1 through 28
57-84	Load data for condition 3

TABLE 72. FUS ARRAY VARIABLES (CONCL)

Location	Description
85-112	Load data for condition 4
113-140	Load data for condition 5
141-188	Load data for condition 6
169-196	Load data for condition 7
197-224	Load data for condition 8
225-252	Load data for condition 9
253-280	Load data for condition 10
281-308	Load data for condition 11
309-336	Load data for condition 12
337-364	Load data for condition 13
365-392	Load data for condition 14
393-420	Load data for condition 15
421-448	Load data for condition 16
449-476	Load data for condition 17
477-504	Load data for condition 18
505-532	Load data for condition 19
533-560	Load data for condition 20
561-588	Load data for condition 21
589-616	Load data for condition 22
617-644	Load data for condition 23
645-672	Load data for condition 24

SUBROUTINE FATMG

General Description

Deck name: FATMG
Entry name: FATMG
Called by: BLCNTL
Subroutines called: USPAN, ATMOS
Function routines called: CODIM2, FCODM2

This subroutine calculates bending moment spectra at a wing side of body station (unswept) and at an outboard swept span station. Maneuver and gust spectra are calculated for eight flight segments. Two taxi segments and a ground-air-ground segment are also calculated. Methods described in Section II of this report are used to calculate spectra data.

For the eight flight segments, this routine:

1. Uses the appropriate blocked mission segment tables (DS array) to obtain vehicle weight, altitude, and Mach number.

2. Calls USPAN to obtain the spanwise loading distribution and unit unswept bending moment at the side of body station.

3. Calls CODIM2 to interpolate spanwise loading distribution for the swept unit bending moment at the outboard wing station.

4. Calls CODIM2 to interpolate inertia data (BC array) for the appropriate inertia bending moments at the two wing stations.

5. Calculates maneuver exceedences by using table data (DE array).

6. Calls ATMOS to obtain air density and speed of sound at spectra segment average altitude.

7. Calls CODIM2 to interpolate DG array tables for turbulence field parameters.

8. Calls FCODM2 to interpolate DR array tables for gust response factors.

9. Calculates 1 g bending moments, spectra bending moments, gust exceedances, and maneuver exceedances.

Taxi spectra, segments No. 9 and 10, are calculated at the designated vehicle taxi and landing weights. Taxi load factor table data (DI array) and inertia data (BC array) are used to calculate exceedances and bending moments.

Segment No. 11 is the ground-air-ground spectra. Airload bending moments are obtained from the first flight segments. The flight moments are calculated for a load factor which is half of the maximum vehicle maneuver load factor. Ground moments are calculated for 1.2 g taxi

Calculated spectra data are stored in the BO and BMAN arrays. This datum is subsequently transferred to the DUMMY array which is written on mass storage file record 35 for use by the fatigue module.

Arrays and Variables Used

BC Vehicle design data and wing inertia bending moments at fatigue evaluation stations

BU Unit spanwise loading, lift curve slope, and centers of pressure data

DE Permanent file maneuver load factor spectra tables

DG Permanent file turbulence field parameters

DI Permanent file taxi load factor spectra tables

DR Permanent file gust response factors

DS Blocked mission segment tables

NA Air vehicle category indicator

1 = fighter
2 = attack
3 = tactical bomber
4 = strategic bomber
5 = cargo assault
6 = cargo transport

ND Basic loads calculation controls and indicators

Arrays and Variables Calculated

BB Vehicle design criteria at mission segment

NF Load distribution calculation control
1 = wing only, flaps up

Scratch Arrays and Variables

BD	Refer to Table 73
BMAN	Maneuver exceedences. refer to Table 76
BO	Spectra bending moments and exceedences, refer to Table 75
BS	Refer to Table 74
DUMMY	Refer to Tables 75 and 76
I	Scratch counter
J	Scratch counter
K	Scratch counter
L	Scratch counter
LIMIT	Scratch counter
L1	Scratch counter
L2	Scratch counter
M	Scratch counter
N	Scratch counter
NG	Scratch counter
NN	Scratch counter
NS	Spectra segment number counter
NY	Blocked mission segment type indicator

Labeled Common Arrays

IQ(55)	1 = Print output of wing bending moment spectra data 0 = Do not print

Mass Storage File Records

Records 5-9, 35

Error Messages

None

TABLE 73. BD ARRAY VARIABLES IN SUBROUTINE FATMG

Loc	Engrg Symbol	Description
1		Maneuver exceedences for spectra load factor 1
.		To
20		Maneuver exceedences for spectra load factor 20
21		Taxi spectra load factor 1
.		To
40		Taxi spectra load factor 20
41	$-\Delta N_Z/\bar{A}B_1$	Exponent for gust exceedence calculation
42	$-\Delta N_Z/\bar{A}B_2$	Exponent for gust exceedence calculation
43	Mx/N_Z	Net unswept bending moment per g at wing side of body station for flight segment
44	$M_{X\Lambda}/N_Z$	Net swept bending moment per g at wing outboard station for flight segment
45		Unswept inertia bending moment per g at wing side of body station for flight portion of ground-air-ground segment
46		Swept inertia bending moment per g at wing outboard station for flight portion of ground-air-ground segment
47	W_L/W_{OF}	Landing weight to taxi weight ratio
48		Unswept inertia bending moment per g at wing side of body station for taxi at landing weight
49		Swept inertia bending moment per g at wing outboard station for taxi at landing weight
50		Half of maximum vehicle maneuver load factor

TABLE 73. BD ARRAY VARIABLES IN SUBROUTINE FATMG (CONT)

Loc	Engrg Symbol	Description
51		Unswept inertia bending moment per g at wing side of body station for taxi at taxi weight
52		Swept inertia bending moment per g at wing outboard station for taxi at taxi weight
53		Not used
.		To
56		Not used
57	W_s	Vehicle weight at flight segment 1
.	.	To
64	W_s	Vehicle weight at flight segment 8
65	ts	Vehicle time at flight segment 1, hr
.	.	To
72	ts	Vehicle time at flight segment 8, hr
73	N_{Z1}	Maneuver load factor at flight spectra point 1
.	.	To
92	N_{Z20}	Maneuver load factor at flight spectra point 20
93	ΔN_{ZG1}	Incremental gust load factor at flight spectra point 1
.	.	To
112	ΔN_{ZG20}	Incremental gust load factor at flight spectra point 20
113		Segment type for flight segment 1
.		To
120		Segment type for flight segment 8

TABLE 73. BD ARRAY VARIABLES IN SUBROUTINE FATMG (CONCL)

Loc	Engrg Symbol	Description
121		Average mach number for flight segment 1
·		To
128		Average mach number for flight segment 8
129		Average altitude for flight segment 1
·		To
136		Average altitude for flight segment 8
137		Wing sweep position indicator for flight segment 1
·		To
144		Wing sweep position indicator for flight segment 8
145		Vehicle weight fraction for flight segment 1
·		To
152		Vehicle weight fraction for flight segment 8
153		Life fraction for flight segment 1
·		To
160		Life fraction for flight segment 8

TABLE 74. BS ARRAY VARIABLES IN SUBROUTINE FATMG

Loc	Engrg Symbol	Description
1	η	Fraction of semispan at outboard wing fatigue evaluation station
2		Not used
3	UMX_{WSB}	Unswept unit airload bending moment at wing side of body station for flight segment
4	UMX_{WS}	Swept unit airload bending moment at wing outboard station for flight segment
5		Unswept inertia bending moment per g at wing side of body station for flight segment
6		Swept inertia bending moment per g at wing outboard station for flight segment
7	ρ	Density of air at spectra segment average altitude, slugs/ft^3
8	P_H	Ambient pressure at spectra segment average altitude, psi
8	V_T	True vehicle air speed for spectra segment
9	C_S	Speed of sound at spectra segment average altitude
10	μ	Vehicle mass ratio for spectra segment
11	P_1	Turbulence field parameter
12	b/2	Wing semispan from subroutine USPAN
12	B_1	Turbulence field parameter, ft/sec
13	P_2	Turbulence field parameter
14	B_2	Turbulence field parameter, ft/sec
15	L	Scale of turbulence, ft
16	$\bar{C}/L$	Average wing chord to scale of turbulence ratio

TABLE 74. BS ARRAY VARIABLES IN SUBROUTINE FATMG (CONCL)

Loc	Engrg Symbol	Description
17	$K\overline{V}$	Gust response factor
18	$\overline{A}$	
19	N_o	Average number of cycles of load factor per second
20	N_{EXG}	Gust exceedences of incremental gust load factor

TABLE 75. BO AND DUMMY ARRAY VARIABLES IN SUBROUTINE FATMG

BO Loc	DUMMY Loc	Description
1	-	Mission segment No. 1 (flight segment) indicator = 1.0
2	1	Net bending moment at side of fuselage for load factor 1, segment 1
3	2	Net swept bending moment at outboard wing station for load factor 1, segment 1
4	3	Gust exceedences for load factor 1, segment 1
.	.	To
59	58	Net bending moment at side of fuselage for load factor 20, segment 1
60	59	Net swept bending moment at outboard wing station for load factor 20, segment 1
61	60	Gust exceedences for load factor 20, segment 1
62	-	Mission segment number 2 (flight segment) indicator = 2.0
63	61	Net bending moment at side of fuselage for load factor 1, segment 2
64	62	Net swept bending moment at outboard wing station for load factor 1, segment 2
65	63	Gust exceedences for load factor 1, segment 2
.	.	To
120	118	Net bending moment at side of fuselage for load factor 20, segment 2
121	119	Net swept bending moment at outboard wing station for load factor 20, segment 2
122	120	Gust exceedences for load factor 20, segment 2

TABLE 75. BO AND DUMMY ARRAY VARIABLES IN SUBROUTINE FATMG (CONT)

BO Loc	DUMMY Loc	Description
123	-	Mission segment number (flight segment) indicator = 3.0
124	121	Net bending moment at side of fuselage for load factor 1, segment 3
125	122	Net swept bending moment at outboard wing station for load factor 1, segment 3
126	123	Gust exceedences for load factor 1, segment 3
.	.	To
181	178	Net bending moment at side of fuselage for load factor 20, segment 3
182	179	Net swept bending moment at outboard wing station for load factor 20, segment 3
183	180	Gust exceedences for load factor 20, segment 3
184	-	Mission segment number 4 (flight segment) indicator = 4.0
185	181	Net bending moment at side of fuselage for load factor 1, segment 4
186	182	Net swept bending moment at outboard wing station for load factor 1, segment 4
187	183	Gust exceedences for load factor 1, segment 4
.	.	To
242	238	Net bending moment at side of fuselage for load factor 20, segment 4
243	239	Net swept bending moment at outboard wing station for load factor 20, segment 4
244	240	Gust exceedences for load factor 20, segment 4

TABLE 75. BO AND DUMMY ARRAY VARIABLES IN SUBROUTINE FATMG (CONT)

BO Loc	DUMMY Loc	Description
245	-	Mission segment number 5 (flight segment) indicator = 5.0
246	241	Net bending moment at side of fuselage for load factor 1, segment 5
247	242	Net swept bending moment at outboard wing station for load factor 1, segment 5
248	243	Gust exceedences for load factor 1, segment 5
.	.	To
303	298	Net bending moment at side of fuselage for load factor 20, segment 5
304	299	Net swept bending moment at outboard wing station for load factor 20, segment 5
305	300	Gust exceedences for load factor 20, segment 5
306	-	Mission segment number 6 (flight segment) indicator = 6.0
307	301	Net bending moment at side of fuselage for load factor 1, segment 6
308	302	Net swept bending moment at outboard wing station for load factor 1, segment 6
309	303	Gust exceedences for load factor 1, segment 6
.	.	To
364	358	Net bending moment at side of fuselage for load factor 20, segment 6
365	359	Net swept bending moment at outboard wing station for load factor 20, segment 6
366	360	Gust exceedences for load factor 20, segment 6

TABLE 75. BO AND DUMMY ARRAY VARIABLES IN SUBROUTINE FATMG (CONT)

BO Loc	DUMMY Loc	Description
367	-	Mission segment number 7 (flight segment) indicator = 7.0
368	361	Net bending moment at side of fuselage for load factor 1, segment 7
369	362	Net swept bending moment at outboard wing station for load factor 1, segment 7
370	363	Gust exceedences for load factor 1, segment 7
.	.	To
425	418	Net bending moment at side of fuselage for load factor 20, segment 7
426	419	Net swept bending moment at outboard wing station for load factor 20, segment 7
427	420	Gust exceedences for load factor 20, segment 7
428	-	Mission segment number 8 (flight segment) indicator = 8.0
429	421	Net bending moment at side of fuselage for load factor 1, segment 8
430	422	Net swept bending moment at outboard wing station for load factor 1, segment 8
431	423	Gust exceedences for load factor 1, segment 8
.	.	To
486	478	Net bending moment at side of fuselage for load factor 20, segment 8
487	479	Net swept bending moment at outboard wing station for load factor 20, segment 8
488	480	Gust exceedences for load factor 20, segment 8

TABLE 75. BO AND DUMMY ARRAY VARIABLES IN SUBROUTINE FATMG (CONT)

BO Loc	DUMMY Loc	Description
489	-	Spectra segment number 9 (taxi) indicator = 9.0
490	481	Net bending moment at side of fuselage for load factor 1, segment 9
491	482	Net swept bending moment at outboard wing station for load factor 1, segment 9
492	483	Exceedences for load factor 1, segment 9
.	.	To
547	538	Net bending moment at side of fuselage for load factor 20, segment 9
548	539	Net swept bending moment at outboard wing station for load factor 20, segment 9
549	540	Exceedences for load factor 20, segment 9
550	-	Spectra segment number 10 (taxi) indicator = 10.0
551	541	Net bending moment at side of fuselage for load factor 1, segment 10
552	542	Net swept bending moment at outboard wing station for load factor 1, segment 10
553	543	Exceedences for load factor 1, segment 10
.	.	To
608	598	Net bending moment at side of fuselage for load factor 20, segment 10
609	599	Net swept bending moment at outboard wing station for load factor 20, segment 10
610	600	Exceedences for load factor 20, segment 10

TABLE 75. BO AND DUMMY ARRAY VARIABLES IN SUBROUTINE FATMG (CONT)

BO Loc	DUMMY Loc	Description
611	-	Spectrum segment 11 Indicator = 11.0 (ground air ground segment)
612	601	Net bending moment at side of fuselage for half of maximum flight maneuver load factor
613	602	Net swept bending moment at outboard wing station for half of maximum flight maneuver load factor
614	603	Number of occurrences of air cycles
615	604	Net bending moment at side of fuselage for 1.2 g taxi
616	605	Net swept bending moment at outboard wing station for 1.2 g taxi
617	606	Number of occurrences of taxi cycles
618	-	Not used
620	-	Not used
NOTE		BO locations 560 to 615 are used to store weight, time, and load factor data for the eight flight segments. These data are transferred to the BD array after completion of flight segments.
560	-	Vehicle weight at flight segment 1
.		To
567		Vehicle weight at flight segment 8
568		Vehicle time at flight segment 1
.		To
575		Vehicle time at flight segment 8

TABLE 75. BO AND DUMMY ARRAY VARIABLES IN SUBROUTINE FATMG (CONCL)

BO Loc	DUMMY Loc	Description
576		Maneuver load factor at flight spectra point 1
.		To
595		Maneuver load factor at flight spectra point 20
596		Incremental gust load factor at flight spectra point 1
.		To
615		Incremental gust load factor at flight spectra point 20

TABLE 76. BMAN AND DUMMY ARRAY VARIABLES IN SUBROUTINE FATMG

BMAN Loc	DUMMY Loc	Spectra Segment	Description
1	627	1	Maneuver exceedances for load factor 1
.	.		To
20	646	1	Maneuver exceedances for load factor 20
21	647	2	Maneuver exceedances for load factor 1
.	.		To
40	666	2	Maneuver exceedances for load factor 20
41	667	3	Maneuver exceedances for load factor 1
.	.		To
60	686	3	Maneuver exceedances for load factor 20
61	687	4	Maneuver exceedances for load factor 1
.	.		To
80	706	4	Maneuver exceedances for load factor 20
81	707	5	Maneuver exceedances for load factor 1
.	.		To
100	726	5	Maneuver exceedances for load factor 20
101	727	6	Maneuver exceedances for load factor 1
.	.		To
120	746	6	Maneuver exceedances for load factor 20
121	747	7	Maneuver exceedances for load factor 1
.	.		To
140	766	7	Maneuver exceedances for load factor 20

TABLE 76. BMAN AND DUMMY ARRAY VARIABLES IN SUBROUTINE FATMG (CONCL)

BMAN Loc	DUMMY Loc	Spectra Segment	Description
141	767	8	Maneuver exceedances for load factor 1
.	.		To
160	786	8	Maneuver exceedances for load factor 20
161	787	9	Maneuver exceedances for load factor 1
.	.		To
180	806	9	Maneuver exceedances for load factor 20
181	807	10	Maneuver exceedances for load factor 1
.	.	.	To
200	826	10	Maneuver exceedances for load factor 20
201	607	1	Net bending moment at side of fuselage at 1 g
.	.		To
210	616	10	Net bending moment at side of fuselage at 1 g
211	617	1	Net swept bending moment at outboard wing station at 1 g
.	.		To
220	626	10	Net swept bending moment at outboard wing station at 1 g
-	827		Not used
	.		
-	830		Not used

SUBROUTINE ATMOS

General Description

Deck name: ATMOS
Entry name: ATMOS (H, RHOH, PH, AH)
Called by: BNLDS, FATMG
Subroutines called: None

This subroutine is used to determine the standard atmospheric density, ambient pressure, and speed of sound for a given altitude. The approach consists of equation approximations of properties for different altitude ranges from sea level to 249,000 feet.

Arrays and Variables Used

H	Given altitude, ft

Arrays and Variables Calculated

AH	Speed of sound at altitude, ft/sec^2
PH	Ambient pressure at altitude, psi
RHOH	Atmospheric density at altitude, $slugs/ft^3$

Scratch Arrays and Variables

GB	Constant dependent on altitude range
GH	Intermediate calculation
OG	Acceleration of gravity at sea level, 32.17409 ft/sec^2
PBASE	Ambient pressure at lower altitude of equation limits, psi
PO	Ambient pressure at sea level, 14.69595 psi
RE	Constant, 20855531.0
RHOO	Atmospheric density at sea level, 0.0023769199 $slug/ft^3$
RO	Constant, 1716.4827
TMB	Ambient temperature at lower altitude of equation limits, °R

TMDH	Temperature variation with altitude, °R/ft
TMH	Ambient temperature at given altitude, °R
TMO	Ambient temperature at sea level, 518.688°R
YP	Intermediate calculation

Labeled Common Arrays

None

Mass Storage Files

None

Error Messages

None

FUNCTION CODIM2

General Description

Deck name: CODIM2
Entry name: CODIM2 (X, XI, YI, N, XK)
Called by: USPAN, BNLDS, FATMG, FCODM2
Subroutines called: None

Function routine CODIM2 is an interpolation routine for the determination of a point on a single curve. For a given interval, a parabola from the left and a parabola from the right are calculated. The ordinate of each parabola at a given point, X, is weighted both with respect to a straight line and a closeness factor such that the desired function lies within the two parabolas.

Should given point, X, fall outside the range of abscissa values, XI, the desired function is obtained by straight line extrapolation using the two nearest end points.

Should given point, X, fall within the first or last interval, the desired function is determined according to the end interval interpolation control constant, XK.

XK = 0.0 straight line interpolation

XK = 1.0 full parabolic interpolation

0.0 < XK < 1.0 ratio between straight line and parabolic interpolation

Arrays and Variables Used

N	Number of given points describing the curve
X	Independent variable, abscissa argument
XI	Array of N abscissa values
XK	End interval interpolation constant
YI	Array of N ordinate values

Arrays and Variables Calculated

None, desired ordinate returned to equation where the function was used.

Scratch Arrays and Variables

Variables are stored in the program region and are primarily used for intermediate calculations. Pertinent scratch variables are as follows:

BT	Weighting factor with respect to straight line and parabolas
J	Abscissa argument location in XI array
JJ	Interval location indicator

1 = abscissa argument within first interval
2 = abscissa argument within last interval
3 = abscissa argument within intermediate interval

P1	Ordinate value obtained from left parabola
P2	Ordinate value obtained from right parabola
S	Ordinate value obtained from linear interpolation

Labeled Common Arrays

None

Mass Storage File Records

None

Error Messages

None

FUNCTION FCODM2

General Description

Deck name: FCODM2
Entry name: FCODM2(X,Y,XI,YI,ZI,N1,N2,XK)
Called by: USPAN, FATMG
Subroutines called: None
Function routines called: CODIM2

Function routine FCODM2 is an interpolation routine for the determination of a point from sets or families of curves. The desired dependent variable is computed by repeated application of the function routine CODIM2 for a single set of points.

Arrays and Variables Used

N1 Number of curves, YI values

N2 Number of abscissa points describing each curve, XI values

X First independent variable, abscissa argument

XK End interval interpolation control constant

XK = 0.0	straight line interpolation
XK = 1.0	full parabolic interpolation
0.0 XK 1.0	ratio between straight line and parabolic interpolation

XI Array of N2 abscissa values

Y Second independent variable, curve argument

YI Array of N1 curve values

ZI Array of the dependent ordinate values

Arrays and Variables Calculated

None, desired ordinate value returned to equation where the function was used

Scratch Arrays and Variables

I	Scratch counter
K	Scratch counter
L	Scratch counter
N3	Curve value counter
N4	Number of curve interpolations on first independent variables
T	Interpolated values of dependent variable for first independent variable, X, which form the ordinates for the cross-plot.
YX	Array of YI which form the abscissa for the cross-plot

Labeled Common Arrays

None

Mass Storage File Records

None

Error Messages

None

Section IV

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